PUBLIC WORKS

CITY COUNTY STATE

Brighton Plant, Rochester, N.Y., with loading lines for tank cars and motor trucks.

Above: Tank wagon spraying "Tarvia-X" under steam pressure with special Barrett nozzle.

Left: Tarvia Service Station at Syracuse, N. Y., completely equipped to ship in tank cars, motor trucks or barrel lots.

Service!

CALL on our Special Service Department regarding your road problems or the conditions in your vicinity. We gladly put the skill and experience of our engineers at your disposal. This service is free for the asking. If you are interested in *better roads* and *lower taxes*, here is an organization that can be of real service to you.

Tarvia—*When you want it*

In road work, building or repair, nothing is more important than having material on hand *when* it is wanted. Delays and hold-ups on delivery are expensive. Tarvia Service can be depended upon. Tarvia Service is always "on the job."

Tarvia—*Where you want it*

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Motor truck distribution is faster and well worth the slight increase in price necessary to cover the use of the trucks, but equally good results may be obtained with the tank wagon—Barrett nozzle method—as shown in small illustration above.

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JUNE 11, 1921

PUBLIC WORKS.

CITY COUNTY STATE

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Baltimore Waste Disposal Report

Burial, reduction and hog feeding have been tried in succession and now a permanent plant is considered necessary. In his report, Chief Engineer Perring discusses the various methods and their suitability for Baltimore conditions.

The city of Baltimore has, during the past forty years, tried various methods of disposing of its garbage, but has found each in its turn to be unsatisfactory. The latest attempt prior to the existing temporary arrangement, was the entering into a contract with the American Feeding Company to dispose of the garbage by feeding to hogs, this contract going into effect on May 1, 1919. The city delivered the garbage in scows at Graveyard Point and the contractor paid the city for each ton a sum equal to 3½ times the price per pound of live killing hogs on the Chicago market. About January 15 of this year, the American Feeding Company removed its hogs from the farm and abandoned the contract, the city retaining the pens, feeding platforms and railway tracks which the company had built on the farm (which land was owned by the city) to satisfy a claimed indebtedness of about $15,000.

Following this, the city made a temporary arrangement to deliver the garbage on scows to a contractor who pays the city $40 per scow load of approximately 180 tons and sells the garbage to farmers for fertilizing purposes. As the towing and handling of garbage costs the city about $90 per scow load, the city loses about $50 per load or 25 cents to 30 cents per ton in addition to the cost of collecting the garbage and delivering it to the scows. This contract expired April 15.

During the year 1920 the total garbage removed by scows from the water-front dumping station was reported to be 130 scow loads, amounting to 24,269 tons. The city owns and operates eleven scows, five of them 92 feet long by 28 feet wide by 12 feet deep, with a capacity of about 400 tons; five scows 80 feet long by 24 feet wide by 12 feet deep with a capacity of 300 tons, and an eleventh scow of about the same capacity as the smaller size but of a different shape. The larger scows cost the city $8,600 apiece, and the smaller scows $6,000.

As for ashes, the city has used these to great advantage in filling in low land and thus making many acres of valuable building land in the city, although the dumps have been more or less of a nuisance because of careless maintenance. The street cleaning department reported for the year 1920 that it collected 43,000 cubic yards of mixed ashes and rubbish at a cost of $369,704, and it is estimated that the ash collection cost $1.27 a ton and the rubbish collection $5.02.

In view of the necessity of making some permanent arrangement for disposing of the garbage, Mayor Broening asked H. G. Perring, chief engineer of the Department of Public Improvements of Baltimore, to report on the most feasible method of disposing of the city's garbage and, under date of April 9, Mr. Perring submitted a report, of which an abstract is given herewith.

In considering the subject, attention must be given to: "(1) The danger to health through the possible bearing of infectious and contagious diseases in city wastes; (2) the possible spread of rats, mice, flies, mosquitos and other vermin; (3) the producing of annoying and foul odors, either for long-continued periods or even for short stretches of time; (4) unsightliness; (5) that intangible, psychological effect which has to do with the self-respect of persons who object to living near a dump or near any place where the city disposed of its wastes.

"In arriving at a solution we must not only consider the residents of our city, but we must also be on good terms with our adjoining neighbors in the state and must not do anything that will create a dangerous or offensive condition to them."

The largest part of the expense connected with city waste is that of the collection of them and, from a financial viewpoint, the actual ultimate disposal is of relatively small importance.

Baltimore has reached the size where it must decide upon some permanent method, the cost of any plant for disposal being now too great to permit of further experimentation. The necessity for immediate action, however, is not so urgent as many think. The city owns a farm just across the creek from the land used by the

American Feeding Company, which farm contains 157 acres of nearly level land with sandy soil and a 300-foot wharf. There is no question in Mr. Perring's mind that the garbage of the city can be disposed of for a year or more in a perfectly sanitary manner by hauling it to this city farm and burying it in trenches. He is confirmed in this opinion by Dr. John H. Gregory, of Johns Hopkins University, who used this method of disposing of the city garbage of Columbus, Ohio, for four years prior to the installation of the reduction plant by that city. From 1882 to 1901 Baltimore disposed of its garbage by spreading it over the ground and plowing in (but presumably not in the sanitary method contemplated by Mr. Perring). From 1902 to 1919 the garbage was disposed of by the reduction process under two different contracts, and during the early part of 1919 it was again disposed of by burial in trenches 18 inches deep by 5 feet wide, a 12-inch layer of garbage being covered with 6 inches of soil.

RECOMMENDED METHODS OF DISPOSAL

The greater part of this report is devoted to a consideration and comparison of the various methods which seemed to be practicable for Baltimore, these including hog feeding, reduction, incineration, fuel briquetting and utilization for stock feeding. Summing these up, Mr. Perring concludes that the cost of disposing of garbage, rubbish and ashes, including collection, should not exceed $1.25 per capita per year, while 35 cents is already being paid by the citizens for removal of ashes. He recommends that the householders be required to make careful separation of the wastes into ashes, rubbish and garbage; that the ashes be used for filling streets and low lands, that rubbish be burned in four incinerators, each containing two 15-ton units, to be built in convenient parts of the city, saleable material being salvaged at these plants; and that garbage be removed to a single reduction plant. Ashes would be collected twice a week in the outlying districts and more frequently in the congested districts, rubbish would be collected once a week, and garbage would be collected daily from April to October and three times a week from October to April.

The garbage should be removed quickly to relay stations, and thence to a reduction plant by truck and trailer, by trolley, railroad, scow or other means. The reduction plant should have a present maximum daily capacity of 300 tons and should be built in one or two localities, either near existing fertilizer factories or near the sewage disposal plant. The city should endeavor to collect every pound of garbage and under no circumstances permit collection by private parties. It should own and operate its collection equipment and disposal plant. No storage of garbage for more than one day should be allowed at any point. If scows are used for removing the garbage, they should make trips to the disposal plant each day, even though but partly loaded. He recommends that the use of truck and trailer in garbage and waste collection be carefully investigated; in fact, that the whole system of collection be studied carefully with a view to reducing the cost.

Collection of refuse from houses in the outlying sections is unduly expensive and in many cities is largely neglected. It is recommended that houses built in the outlying sections of Baltimore be required to be equipped with some form of individual incinerator for garbage and rubbish.

He estimates the cost of a 300-ton reduction plant as $1,000,000, and of the four incineration plants as $180,000, this cost including the sites and engineering as well as the plant, buildings, etc.

Meantime, while the method of final disposal is being decided upon and the plant constructed, the garbage should be taken to the city farm and buried under the following conditions: The scows should not be held at the loading wharf more than 24 hours; the garbage on the scows should be covered with land plaster and disinfectant; the scows should be properly cleaned at the discharging end of each trip. The garbage should not be stored at the farm but should immediately be buried in trenches and covered with 6 inches of earth or sandy loam after being spread with land plaster. If this temporary disposal be performed by contract, the contractor should give an adequate bond and the contract should be revocable by the Board of Awards if sanitary conditions are not maintained, and regular inspection should be made by the street cleaning department to secure such conditions. The city should have power to correct sanitary defects at the expense of the contractor without annulling the contract, within 10 hours after notification of the contractor to remedy the condition and his neglect or refusal to do so. The contractor should be allowed to remove any fertilizer produced by decomposition of buried garbage, if the same can be done in a sanitary manner, within one year after the termination of the contract.

HOG FEEDING

In considering the various methods available, Mr. Perring assumes that, if hog feeding be adopted, the city would require 15,000 hogs to consume about 150 tons of garbage a day; that each hog would gain an average of one pound a day in weight and would be sold as soon as it had gained 100 pounds. The interest for 100 days on the plant and equipment would average 29 cents per hog, the fixed charges would be $5, the labor of feeding $1.50, loss through death (estimated at 10 per cent of the herd) $1, a total of $7.79 for producing 100 pounds of pork. If this sold at 10 cents a pound the net return would be $2.21. If 20 pounds of garbage will produce a pound of pork this would give a net return of $2.21 per ton of garbage; or the return would be 88 cents if it required 50 pounds of garbage per pound of pork. As it cost the city last year 50 cents a ton to barge the garbage from the waterfront to the piggery, and $5 to collect and haul it to the water front, this would give the net cost per ton $4.62.

"As success in operating a piggery depends on good management and prompt delivery of the garbage in a fresh state, it is doubtful whether as

good results as above indicated would be obtained from hog feeding by city employees. Under the contract recently abandoned by the American Feeding Company, which provided for their payment to the city for each ton of garbage delivered to the piggery a sum equal to 3½ times the price per pound of live hogs in Chicago, the theoretical cost to the city for collection and disposal was" $5.22, which includes $5 for collection, 50 cents for transportation and 7 cents for interest on the city's investment at the plant, less 35 cents paid to the city by the contractor on a basis of pork at 10 cents a pound in Chicago. "These theoretical figures have not been realized and, in fact, the city has received no return but has been placed at considerable expense due to the failure of this method of disposal from various causes. Returns from hog feeding are altered vitally by a drop of a cent or two in the price of live pork between the time the shoats are purchased and the time when the fattened hogs are sold.

Hog feeding, if successfully practiced, requires the careful selection of the richer grades of garbage and the rejection of the remaining portions. Whether or not this is done, the hogs themselves will reject considerable quantities of the green garbage and all of the rejected matter must be disposed of by incineration, burial or otherwise. A disadvantage in the case of Baltimore is that the state of Maryland Live Stock Commission has ruled that it will not permit the use of garbage as a feeding material without it is first sterilized, although many authorities claim that sterilizing garbage before feeding to hogs is inadvisable.

The most important arguments for hog feeding were those of patriotism and financial returns, neither of which apply now that the war emergency conditions have passed.

DISPOSAL BY REDUCTION

It is estimated that a reduction plant sufficient to dispose of Baltimore's present garbage would cost between $750,000 and $1,250,000. Assuming $1,000,000, with 15 per cent for interest and depreciation, and that 53,000 tons of garbage would be reduced per year, the fixed charges per ton of garbage would be $2.83. It is estimated that the operating costs would include $2 per ton for labor, $1 for fuel and 40 cents for gasoline, or a total of $3.40 per ton for operating costs, or of $6.23 for both overhead and operating costs.

Assuming a yield from a ton of garbage of 45 pounds of grease at 4½ cents a pound and 220 pounds of tankage at $5 a ton gives a total return of $3.13 or a net cost of reduction of $3.10; to which should be added $5.50 for collecting the garbage and bringing it to the plant by barge—a total of $8.60.

Mr. Perring stated that the garbage reduction plant in Philadelphia is operated without nuisance within three miles of the city hall and within one mile of a fine residential section.

INCINERATION

To burn the garbage, either fuel or combustible waste must be used. If the latter is used, there should be about 30 per cent of combustible waste to 70 per cent of garbage. Investigation in 1914 and 1915 of the relative quantities and calorific values of the garbage, ashes and rubbish collected in the city of Washington at different seasons of the year indicated that the summer production of combustible wastes would not be sufficient to incinerate the summer garbage. If the same condition obtains in Baltimore, it would be necessary to store part of the winter wastes for use in the summer or else to burn coal during the summer months.

If incineration is employed, it is recommended that four plants with a combined daily capacity of 250 tons, be located at different parts of the city to reduce the length of haul to a minimum. Their cost is estimated at $375,000. Interest and depreciation on this at 15 per cent give fixed charges of $1.06 a ton, while operation is estimated to cost $1.20 for labor, 30 cents for fuel (used during four months) and 24 cents for disposal of residual ash and clinker (at $2 a ton and ash equaling 12 per cent of matter consumed). This gives a cost of incineration of $2.80 per ton of garbage. In addition, the cost of hauling refuse to the incinerators would probably be 50 cents a ton less than hauling it to the water front, giving a total cost of $7.30 a ton, as against $8.60 for reduction and $5.22 for hog feeding. It is to be noted that this method provides for the disposing of all the rubbish and garbage collected by the city.

"Disposal by incineration as outlined above involves the erection and operation at convenient points within the city of four plants. Residents in these neighborhoods and owners of near-by property would object to the idea of garbage disposal plants being placed in their midst. Even if the stacks emitted no odors, the constant passing to and fro and dumping of garbage wagons would be a disagreeable feature not entirely imaginary."

If a single incineration plant were built at a location similar to that for the reduction plant, there would be a longer haul for both garbage and the refuse required to burn it, and it is estimated that there would be added to the cost about $1.50 per ton of garbage, making the cost of collection, removal and disposal $8.80 a ton as against an estimated cost of $8.60 for reduction.

OTHER METHODS

Quite a few houses in Baltimore are equipped with individual incinerators for burning both garbage and rubbish, which seem to operate satisfactorily and with no nuisance. To equip the whole city with these would cost about $10,000,000. If the city paid for the whole equipment, the ultimate cost of the disposal of rubbish and garbage would be about the same as under the plan recommended but it would require a much greater capital outlay although entirely eliminating the cost of collection. It is not considered feasible to adopt this plan for the whole city, but it is recommended for outlying districts and it is suggested that the city might be justified in bearing part of the expense of constructing the household incinerators in such districts.

Concerning briquetting of garbage, it was stated that this is practicable although it was tried in Philadelphia 20 years ago and abandoned. However, it is believed that the commercial development of such a scheme should be positively demonstrated before a large city considers it.

Another proposition was to cook and dry the garbage and grind it as an ingredient for the manufacture of stock feed. The process should be sanitary and free from objectionable odors. It involves the separation from the garbage of metals, glass, etc. Although Toledo, Ohio, is building a plant for this form of utilization it is not yet in operation and the plant must still be considered as experimental.

World's Longest Tunnel for New York's Water Supply*

Conclusion of article in last week's issue. Special features of construction in unfavorable work. Contractor's plant.

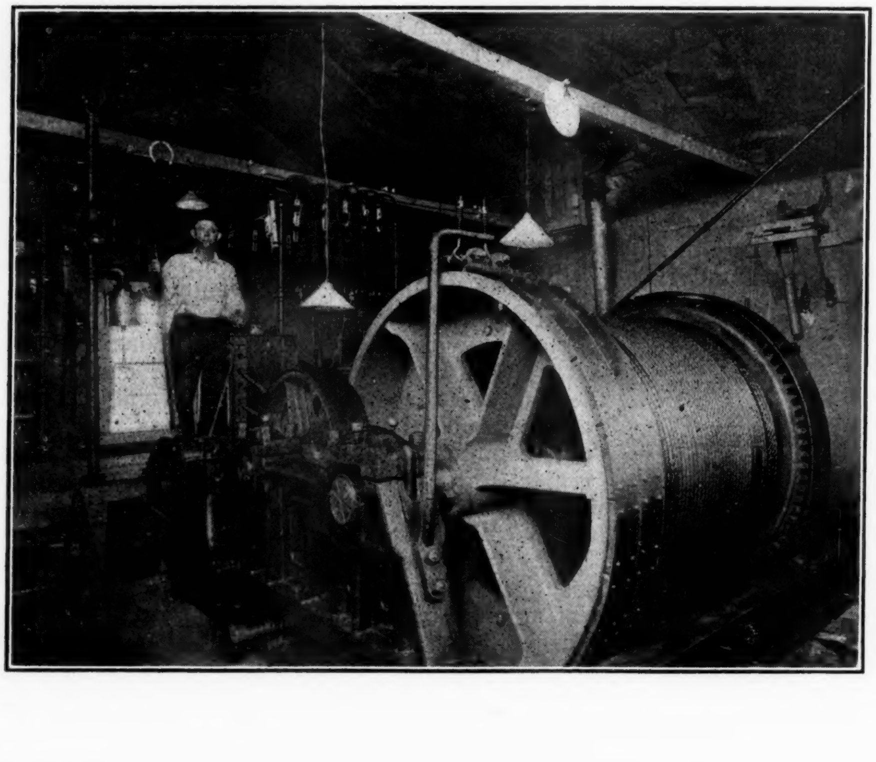
SPECIAL FEATURES AT SHAFT 6

On each side of shaft No. 6 occur the highest mountains, their peaks extending about 2,000 feet and 2,215 feet, respectively, above the invert of the tunnel. Here the rock seems to be still under stress, although perfectly solid. This shows itself in a spalling off of the roof after the tunnel section has been excavated. There is no tendency for any large falls of rock in the roof, but there is a continuous breaking off of rather small pieces of sound rock. It does not therefore necessitate any very strong lining to uphold the roof, but a sheathing is necessary to prevent injury to the men by the falling pieces. Moreover, it is thought that a comparatively light pressure exerted by roof timbering may prevent altogether the progressive spalling which in time would increase the height of the tunnel roof to an undesirable extent.

(*Continued from Page 471)

In this section, therefore, it is found necessary to timber the roof of the tunnel, and to keep this timbering completed very close behind the excavation. The timbering employed consists of bents placed a maximum distance of 7½ feet apart, each bent consisting of three timbers, the middle one horizontal and the others making an angle of about 45 degrees. These inclined side pieces were originally planned to be supported by resting their ends in "hitches," or shoulders excavated in the rock. It was found difficult, however, to complete a hitch furnishing solid support at the exact elevation desired and the contractor suggested and was permitted to use an alternative plan which has worked out very satisfactorily. Each end of a bent is supported by three 1¼-inch square steel pins 24 inches long driven horizontally 18 inches into the rock and placed about 3 inches apart horizontally. On these pins rests a 3-inch bearing plate, and on this plate the foot of the bent timber. Another alternative was to support the bent on posts placed in recesses in the sides of the tunnel; but the plan adopted avoids excavating for these posts and also keeps the entire timbering out of the way of the mucking cars and all working done in the tunnel.

This timbering is all placed above the outside line of the tunnel lining, there being a clearance of 17 inches between the bottom of the horizontal timber of the bent and the interior of the lining. On top of the bents are placed lagging boards of 3-inch by 6-inch material. These are spaced about an inch apart, thus allowing channels for the grout to follow in grouting the tunnel after the completion of the lining. The space



HOIST HOUSE AT SHAFT No. 1

SHOWING ELECTRIC HOIST. THE HOIST HAS A DRUM 4 FEET 6 INCHES IN DIAMETER AND IS BALANCED BY ONE CABLE ASCENDING WHILE THE OTHER IS DESCENDING. FULL CONTROL IS OBTAINED AT ALL TIMES BY MEANS OF A SOLENOID BRAKE AND A HAND BRAKE. IN CASE OF AN OVERLOAD OR ANYTHING HAPPENING TO THE CAGES, A SWITCH TO THE RIGHT OF THE OPERATOR'S HEAD CAN BE THROWN OUT, THUS SETTING THE SOLENOID BRAKE. THERE IS ALSO A CIRCUIT BREAKER, WHICH IN CASE OF AN OVERLOAD WILL AUTOMATICALLY THROW OUT. THE HOIST IS DRIVEN BY A "GENERAL ELECTRIC" 112-HORSEPOWER, 440-VOLT, 60-CYCLE, 154-AMPERE, 3-PHASE, INDUCTION MOTOR; SPEED, FULL LOAD, 150 REVOLUTIONS PER MINUTE. THIS DOES NOT SHOW IN THE PICTURE, BUT IS DIRECTLY BACK OF THE HOIST. TO THE LEFT IS A SERIES OF GRIDS THROUGH WHICH THE CURRENT HAS TO PASS BEFORE GOING TO THE MOTOR.

between the lagging and the tunnel roof is dry packed with rock fragments. After the completion of the concrete lining it may or may not be thought necessary to force grout into the dry packing.

In the tunnel north and south from shaft No. 6 wrought iron pipes are built into the roof timbering to be used in case it is decided to grout the dry packing in the roof, these pipes extending to within an inch or two of the face of the rock to be used as overflow pipe to determine when the roof space has been entirely filled with grout. Pipes for introducing the grout will be built in the concrete and will be set later when the concrete forms are placed, if it then seems probable that grout will be employed.

In driving the tunnel from shaft No. 6 the work was originally done by the top heading and bench method. On account of the necessity of keeping the roof timbering so close to the forward end, this was changed to a bottom heading with a bench above. This also, however, was soon discontinued, and the work now is being performed by excavating the full section, the entire face being shot at one time. In the two headings from this shaft the work does not progress quite so rapidly as at the others. Each heading alternates two blasts one day and one blast the next, thus averaging 1½ a day. The progress averages 60 feet a week as against 90 to 100 feet in the other shafts.

The material from the tunnel is wasted in spoil banks around the head of the shaft on land purchased by the city for this purpose. In addition to an easement of the land over the tunnel, the city has purchased the properties around the shafts as well as the area of the reservoir; the total amount of area taken being 2,452 acres in fee and 51 acres of easement.

CONTRACTOR'S PLANT

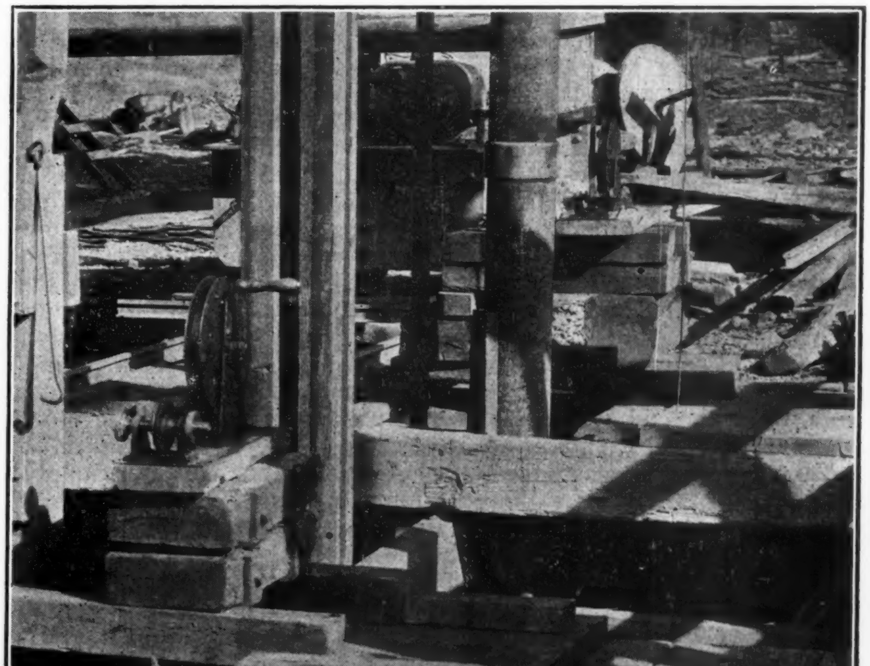
For power on the construction work the contractors on both the tunnel and the reservoir are using electricity furnished by the Central Hudson Gas & Electric Company, which has run its cables for this purpose a distance of about 50 miles in from its main trunk line which extends along the Hudson river. These are on wooden posts rather than steel towers, the line being looked upon as temporary only. The current is furnished under private contract between this company and the contractors.

All of the power is derived from this current, but the drills and some of the pumps are operated by compressed air furnished by compressors operated by electricity, and the locomotives that haul the mucking trains are operated by storage battery.

The compressor plant at each shaft consists of two Chicago Pneumatic Tool Company compressors, each furnishing 741 cubic feet of free air per minute. The compressor is class O-CB low pressure cylinder 17 inches, high pressure cylinders 10 inches, stroke 12 inches, speed 235 r. p. m., 130 h. p., with 6-inch inlet and outlet pipes. This is run by a G. E. synchronous motor, 150 k. v. a., 130 h. p., 600 r. p. m., 60 cycle, 196 ampere, 400 volt, 3 phase.

Compressed air is carried to the tunnel headings through 4-inch pipes. Ventilating air is delivered into the tunnel through a 6-inch steel pipe by Connersville blowers. Water for the drills is pumped into the tunnel through a 2-inch pipe. Cables also carry current into the tunnel for operating the incandescent lights and for furnishing the 220-volt current used by the mucking machine and pumps.

In the hoist house at each shaft is a Flory electric hoist with a 4 foot 6 inch drum, balanced with one cable ascending while the other is descending. Full control is maintained by means of a solenoid brake and a hand brake. In case of an overload or for other reason, a switch at the



VIEW AT THE TOP OF SHAFT No. 5, SHOWING METHOD OF GIVING TUNNEL ALIGNMENT. ON EACH SIDE OF THE SHAFT IS A LINE DROPPING REEL CARRYING SEVERAL HUNDRED FEET OF No. 8 PIANO WIRE. THIS WIRE PASSES OVER A WHEEL (SHOWN IN FRONT OF EACH REEL) HAVING A DEEP "V" GROVE IN ITS CIRCUMFERENCE AND ADJUSTED IN HORIZONTAL POSITION, BY MICROMETER SCREWS, TO THE TUNNEL ALIGNMENT AS GIVEN BY A TRANSIT. THE WEIGHT SHOWN SUSPENDED AT THE ENDS OF THE WIRE ARE THEN LOWERED UNTIL THEY REST IN WATER IN BUCKETS AT THE FOOT OF THE SHAFT. FROM THESE WIRES, WHICH ARE ABOUT 11 FEET APART, THE LINE IS PROJECTED INTO THE TUNNEL. CONCRETE WEIGHTS HEAVIER THAN THOSE SHOWN ARE NOW BEING USED.

right of the operator's head can be thrown out, thus setting the solenoid brake. There is also a circuit breaker, which will automatically throw out in case of overload. This hoist is driven by a G. E. induction motor, 112 h. p., 440 volts, 60 cycle, 154 amperes, 3 phase, 150 r. p. m. At each plant there is a transformer station where the current is stepped down 2,200 volts to the 440, 220 or other voltage required by the several pieces of machinery and for lighting.

The drills used in the headings are all water Leyner drills manufactured by the Ingersoll-Rand Company, while the drilling in the bench is done by means of jackhammer drills manufactured by the same company. Sixty per cent dynamite is used, although a trial is being made just now of 40 per cent.

The muck is carried to the shafts in trains, each containing six cars hauled by a G. E. storage battery locomotive having two 5 h. p. motors, direct connected, 110 volts, the storage battery containing 48 cells. Eighteen cars are used for each heading, one train coming out full while another is being loaded and while the cars of a third are being lifted to the surface, emptied on spoil bank, and returned.

For performing the mucking, two or more types of mucking machines were tried and four of such machines manufactured by the Myers-Whaley Company have been purchased. The machines used are a No. 4 type mucking machine operated by a 20 h. p., 220 volt, 60 cycle, 49 ampere, continuous motor. This mucking machine consists of a small shovel which is pushed under the muck and throws it on to an endless belt, which carries it to the rear of the machine, where it falls into muck cars, which are run up one at a time under the overhanging belt. The endless belt is made in two sections, the forward one discharging on to the rear, and the rear one being pivoted near where the two belts meet, so that it can be swung several degrees either side of the axis of the machine. It is possible with this machine to load a 1½-yard car in about two minutes. Some quite large stone were being handled at the time of the writer's visit, one about 4 or 5 feet long, which is undoubtedly larger than it was intended that the mucker should handle. In shaft No. 6 about 50 cubic yards of rock is blasted at each shot and this is handled by the mucking machine and cars in about five hours, giving 10 cubic yards an hour. A large part of this time, of course, is consumed in shifting cars, each car as it is loaded having to be removed from under the end of the belt of the mucker and an empty run in to replace it.

Very little water enters the tunnel at any point. At shaft No. 1 about 65 gallons a minute is being pumped out through the shaft with about 4,000 feet of tunnel opened, and at shaft No. 6 only about 5 gallons of water per minute is being pumped, practically all of which enters in the shaft itself, so that in the tunnel the only water is that supplied from the surface for the drills. At shaft No. 1 the water is raised to the surface by a Gould triplex plunger pump electrically operated, while about 1,000 feet from the shaft is a booster pump of similar make. As the northern heading slopes downward from the shaft, water accumulates there and is pumped back through a drainage line, a small Cameron pump operated by air taking water from a sump near the heading.

State laws and regulations of the Board of Water Supply require strict adherence to sanitary regulations in the camps and the tunnels, chiefly with a view to protecting the water supply from contamination. (All camps are on either the Esopus or Schoharie watershed.) They also specify how the workmen shall be housed. For each group of houses there is a convenience station provided with chemical toilets, shower baths, etc. Each stream receiving drainage from a camp is treated with a heavy dose of liquid chlorine (about 10 pounds) at a point below probable contamination. In each tunnel heading is a toilet carried on a car which is taken to the surface daily to be emptied.

Each house holds eight or sixteen men in most cases. They are divided into rooms, each for two men with a cot apiece, a window in each room. In the center of the building is a stove for heating. The room partitions are carried about eight feet high only, giving abundant ventilation between the tops of the partitions and the roof. The floors are well above the ground, which prevents dampness. Windows and doors are screened.

ENGINEERING

For aligning the tunnel the line is carried down the shaft by means of two No. 8 piano wires suspended from the surface and carrying at the bottom concrete weights weighing 40 pounds each, made in the section of a cross and suspended in a pail of water. (It requires about 10 minutes for the vibration of the wires to cease after they have been adjusted in alignment.) The wires are adjusted by running each of them over a vertical wheel with a deep, sharp V notch in the circumference, which wheel is adjusted horizontally by means of a micrometer screw. The wires are little over 11 feet apart and hang free just inside the lining of the shaft. They are set by transit on the surface, permanent stone monuments being located on each side of the shaft head to be used for this purpose. The line is carried forward in the tunnel by means of brass scales set in the roof, an instrument platform being suspended from the roof under each scale and the center line being marked on each scale. Twenty-four observations are taken by a shifting-head transit for fixing each alignment point.

The work is under the immediate charge of George G. Honness as department engineer, J. Waldo Smith being chief engineer of the Board of Water Supply and Thaddeus Merriman deputy chief engineer. The work is divided into three sections, each in charge of a division engineer. The Allaben or southern division is in charge of Charles M. Clarke, William B. Hunter is in charge of the Prattsville or northern division of the tunnel, and James A Guttridge is division engineer of the Gilboa division, which includes the Gilboa dam and reservoir. Thomas S. Shepperd is general superintendent of the Shandaken Tunnel Corporation.

Important Features of Highway Design

More attention needed to principles, standards and economics. Continued and assured Federal aid essential.

That the great importance of increasing the mileage of hard-surface roads in this country is being recognized is indicated by the estimate that there is now available from all sources the sum of $1,130,000,000 ready to be used in 1921 for highway work in the United States.

Labor, materials and transportation enough to require all this expenditure will not be forthcoming, nor will plans be perfected and preliminaries completed for so much work this year, but the prospect is inspiring for the future and plans should be made to maintain increasing road activities in the future, remembering that legislation and systemization are necessary and that such efforts progress slowly.

Special attention should be given to co-ordination and co-operation between local, state and Federal authorities and the development of economical, comprehensive and efficient systems of through routes, trunk lines and feeders.

The proper design and construction of future roads requires systematic and comprehensive study of the relation of soils to road design, particularly a consideration of surface failures in certain kinds of soil. Attention should also be given to the control of road materials by laboratories and tests.

Improved standards must be developed, but cannot properly be fixed until after the development of highway economics, the rational application of which will establish some facts at variance with the ordinarily accepted doctrines. It will, for instance, sometimes be found permissible that a road should be designed and constructed with a life considerably less than that of the bonds required to finance its building, as when the opening of the road will immediately insure important traffic that will rapidly develop the adjacent country, create wealth and increase business.

Sometimes, too, the construction of a road with strength or durability known to be less than the maximum requirements will be justified by the greater rapidity of construction or the amount of service it can probably perform before it fails and by the ultimate total cost of construction, maintenance and reconstruction for a certain period of years. This is illustrated by 4-inch concrete roads in California, that, as compared with much thicker roads than would have lasted longer have had a higher ratio of value to cost than have the more expensive roads.

In many states Federal standards should be adopted for improvements, such as width of roadway, alignment, grade crossings and building of permanent drainage structures. Attention should also be given to some important details, such as the construction of shoulders, and to appurtenances like parapets, guards, sign posts, signals, lighting, and to the best realization of local resources for materials and personnel.

It must be remembered that, especially with the rapidly increasing traffic from millions of automobiles already in service in this country there has arisen the necessity of constructing and maintaining important highways over comparatively long stretches of undeveloped or uninhabited country where the local residents cannot be expected to finance the project and the government must bear a large portion of the cost, which will eventually be more than justified by the benefit to the entire area and adjacent sections.

PROPORTIONS OF DIFFERENT CLASSES OF CONSTRUCTION

A large amount of roads must be built, and while the costliest and most durable hard surfaces are automatically being adopted for the business centers, it is necessary to build a very large mileage of lower cost roads selected with proper consideration for local conditions and requirements. At present Federal roads are put under four classes, the total mileage and cost of which up to January 1, 1921, are shown in the following table:

Type	Mileage	Per cent of mileage	Total cost	Per cent of total cost
Class 1.				
Earth	3,701	21.5	$21,763,989	7.7
Sand-clay	1,721	10.0	9,854,570	3.5
Shell	27	.2	296,801	.1
Gravel	5,583	32.5	47,151,795	16.8
Gravel (surface treated)	355	2.1	4,136,533	1.5
Total	11,387	66.3	83,203,688	29.6
Class 2.				
Water-bound macadam	342	2.0	5,258,779	1.9
Water-bound macadam (surface-treated)	97	.6	1,433,499	.5
Bituminous macadam	714	4.1	16,669,782	5.9
Total	1,153	6.7	23,362,060	8.3
Class 3.				
Rock asphalt	51	.3	1,978,293	.7
Bituminous concrete	496	2.9	15,064,756	5.3
Concrete	3,308	19.2	120,629,308	42.9
Brick	351	2.0	15,725,494	5.6
Sheet asphalt	48	.3	1,572,472	.6
Total	4,254	24.7	154,970,323	55.1
Class 4.				
Undetermined	392	2.3	19,796,607	7.0

Economy in Designing Roads

In view of the thousands of miles of roads that are being built each year, each mile costing several thousand dollars in most cases, economies which seem minor become of important magnitude when spread over the entire annual expenditure in this country. In his recently issued book on the "Location, Grading and Drainage of Highways," Wilson G. Harger states that during the years 1913 to 1920 he carefully reviewed plans for some two thousand miles of road from different sections of the country with the idea of forming a conclusion as to the trend of highway design and to learn how closely current practice followed well-recognized principles of highway engineering. He came to the following conclusion:

"About 25 per cent could be classed as first-class designs from an economical standpoint. Practically all the designs showed minor wastes, but for the plans classed as good, revisions would

not result in any practical advantage. About 75 per cent of the plans showed a material expenditure of money for which no adequate return was obtained, amounting to from 5 to 20 per cent of the cost. On some of the roads which, as built, served the traffic well, this excess might better have been spent on other jobs. On some of the roads which, as built, were not up to the requirements of the traffic, the waste might better have been applied to their own improvement in fundamental features.

"The general faults most noticeable were:

Too much spent on the reduction of intermediate grades.

Too much spent to obtain long straight grades.

Too much spent on sections with deep ditches.

Not enough spent on re-alignment at dangerous locations.

Not enough spent on re-location necessary to get reasonable maximum grades.

Not enough spent on long-span bridges.

Too much spent on width of macadam.

Not enough spent on depth of macadam.

Too much spent on imported materials where local materials were available in limited quantities.

"Systematic grading design will often reduce the work from 500 to 2,500 yards per mile, amounting in money, on an average, to from $500 to $1,000 per mile. The proper use of local material, particularly in foundations, is a large factor in economy and will often reduce the cost from $1,000 to $3,000 per mile. Reasonable variations in pavement width and in the thickness of surfacing courses is effective and in many cases saves from $1,000 to $2,000 per mile. A very conservative estimate of savings due to these systematic minor alterations is from $1,000 to $2,000 per mile. These savings are not spectacular for any one job, but if constantly used their advantage on any large program is very evident. They will more than pay for all the necessary engineering work in connection with the entire program. The small additional work required for a careful analysis is the best possible engineering investment for the community that can be made."

Special Engineering Construction Lectures

The necessity of giving instruction to engineering students in so many vital academic subjects makes the curriculum of the technical college a severe one, and leaves little time for any requirements that can be dispensed with. It has been, however, for several years, customary for practising engineers to give advanced students lectures describing the design and construction of important engineering work, generally in their own practice. Such lectures are usually intended to show the students the results to be attained by technical preparation; to arouse their interest in and appreciation of construction operations, and demonstrate their close relation to mathematical and scientific design, without involving much time or study and thus afford a welcomed variety in their routine.

On May 18, Clarence D. Pollock, consulting engineer, New York City, gave a lecture on the Construction of Stone Block Pavements before the civil engineering students in the Junior class, numbering 135 students, at the Massachusetts Institute of Technology.

This lecture was given in connection with Prof. C. B. Breed's course in Railway and Highway Engineering.

The various kinds of stone block pavements were described and the best methods of laying them were explained and the steps in construction were illustrated by lantern slides.

On May 23-24 Frank W. Skinner, associate editor of Public Works, lectured to the Junior and Senior classes in the College of Engineering, Cornell University, on the Construction of Shield Driven Tunnels, the Construction of Concrete Bridges, the Construction of Cribs and Cofferdams and the Construction of the Water Works of New York City, San Francisco and Winnipeg.

These lectures were selected from a long list formerly delivered by Mr. Skinner regularly at the Cornell College of Civil Engineers (this year consolidated with the other Engineering Colleges at Cornell) and occasionally or in part at a dozen other engineering colleges. The lectures outlined the state of the art, ordinary difficulties, requirements, operations, methods and plants, and were profusely illustrated with lantern slides of standard and notable work and equipment.

Water Maintenance in Springfield

During the year 1920 there were 38 leaks in the 237 miles of supply and distribution mains of the water works of Springfield, Mass. an average of approximately one to each six miles of main. Eighteen of these leaks were at defective joints, 3 were broken sleeves, 5 were from cracked pipe, 5 were at hydrant connections, one was the blowing out of an 8-inch plug, one a piece of a burst pipe, and 5 of lesser importance. The total cost of repairing these leaks and of damages paid for flooding the property because of them amounted to $12,603.

The hydrants in that city suffered more than in the previous year from automobiles, 29 having been broken by skidding or carelessly driven cars. Bills for repairing 13 of these have been collected from those responsible for the breakage, 2 had not yet been paid, one had not yet been billed, and 13 were charged to maintenance as it was impossible to learn by whom they were broken.

It is the regular practice as part of the inspection of the system in Springfield to regularly inspect all hydrants and keep them in working condition. Also to inspect the gates and operate them.

Apparently the Springfield department suffers as do so many others that have inherited a system built years ago in that there are no exact records of the location of many of the old mains and valves, as Mr. Martin reports that "the work of inspecting and relocating stop boxes and service pipes is progressing intermittently by the gate inspection gang and sketches made as far as locations can be determined."

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CONTENTS

Construction Certainties

It is certain that there are many hundred million dollars of capital in this country eagerly awaiting safe and profitable investment; it is certain that nearly all kinds of construction are far behind a normal schedule and that billions of dollars' worth of new works, composed chiefly of labor and materials, are required for national comfort and safety, to say nothing of progress; it is certain that considerable numbers of workers of many classes are unemployed, and that very many who are employed are inefficient and unreliable and that many are deliberately fighting for restricted output and disproportionate wages; it is certain that there are and can soon be supplied abundant materials and equipment for executing construction work of all sort; and it is certain that the facilities for transportation and distribution of materials and equipment are not at present operated to full capacity and if coordinated and effective, could handle a vast amount of continuous construction business.

It is thus seen that the financial, commercial and physical factors are all adequate for the immediate resumption of construction in a large and wide field. It is urgently needed and many of the most powerful and best organized interests in this country are earnestly striving to expedite it. Obstructing conditions are gradually being remedied, construction is slowly increasing and we are fully justified in the certainty that construction will steadily increase, acquiring momentum faster and faster, improving general conditions and bringing resumption in all activities in the very near future.

A very experienced and influential contractor has just stated that numerous personal reports from contractors, engineers and officials in widely distributed points throughout the country announce the improvement of construction conditions "from minute to minute," and states his belief that marked and reliable increases will be very large by next fall.

Unlawful combinations and profiteering dealers are being exposed and severely punished. The prices of materials are still generally decreasing. Labor demands are slowly being revised, excessive wages are being reduced and efficiency increased. These corrections must be universally continued with the utmost vigor and persistence. The immediate commencement of billions of dollars of deferred, urgent railroad and municipal improvements, housing and enormous highway construction, as indicated by the discussion on page 504, as well as various vital industrial needs, demand immediate attention, and it is good judgment on the part of those interested to anticipate the inevitable results and to prepare thoroughly in advance for the fast approaching harvest that will yield profits in accordance with the confidence and preparation with which it is met.

Up To Date Tunneling

The construction of the unprecedentedly long Shandaken tunnel for the Catskill water supply to New York City, that is described on page 496, is of unusual engineering importance and is being handled with corresponding skill and experience that has developed notable and interesting features in the design and method of construction.

Although the mountain division of the Hetch-Hetchy aqueduct tunnel for the water supply of San Francisco has also a length of 18 miles, it is interrupted at a point 4½ miles from one portal by a deep narrow valley, which provides two additional portals for the tunnel construction, while the Shandaken tunnel is continuous from portal to portal without any emergence from the mountains under which it passes. This feature involves important considerations of transportation of material and of ventilation as well as the provision of enough working faces to permit the tunnel to be built within the required time. This was attained by the seven intermediate shafts at approximately equidistant locations, at low points in the valleys above the tunnel alignment, although practical developments have indicated that the contractor may find it more advantageous to omit drifting from the foot of one of the shafts and complete the tunnel excavations from the other headings.

A wise appreciation of the value of preliminary investigation led to subterranean exploration by more than 150 diamond drill borings along the proposed alignment to disclose the character and position of the deep rock strata. Considerable time and expense were involved, but were well applied, enabling the engineers to plan in advance for grade and location that promised the most satisfactory tunneling conditions. It caused the rather unusual feature of depressing the intake end of the tunnel 174 feet below the surface, and 135 feet below the hydraulic grade so that the upper end of the tunnel starts at the foot of a shaft, instead of from a portal. Practical reasons have also induced the contractors to drive a heading wholly from the last shaft, rather than from the lower portal, so that the unusual condition is presented of a very long tunnel with no working portals. The horizontal location deviates from a straight line in order to secure most favorable locations for the shafts which at best have an aggregate length of 3,238 feet.

Although the nearly horizontal stratification of the rock and its general quality are favorable and no slide slips are threatened, there is liability of falling from the roof, which is safeguarded or diminished by timbering that is necessarily kept inside of the limits of the concrete lining. In order to avoid a considerable rock excavation for the lower ends of full height bents, the ingenious expedient has been devised of supporting the three-segment roof bents on steel dowels drilled into the rock walls.

The arrangement of the permanent heavy roof lagging is also calculated with a view of providing for the most efficient circulation of grout between the boards if grouting is necessary after the concrete lining is placed. It was originally intended to drive all the tunnel with top headings, but in one heading where this was found unsuitable the contractor did not hesitate to change it to a bottom heading and after some trial again changed to a full face drift with the full dimensions of the finished tunnel, which is found to work more satisfactorily.

The contractors have not hesitatde to install equipment of a quality and amount proportionate to the importance of the work and have invested about $1,000,000 in the plant, for all of which power is derived from electric current brought in on a special line operating motors that drive air compressors and other apparatus, thus saving the cost of hauling coal and maintaining steam plants. The main shafts are fitted with counterbalanced elevators, the most efficient types of drills are selected for the headings and bench work and the muck is handled by several powerful machines that save time and labor by delivering it without hand work to the dump cars hauled by electric storage locomotives, hoisted to the surface and returned to the tunnel in regular succession with equal credit to the engineers and contractors.

Engineers Wanted for California Bureau of Architecture

The California State Civil Service Commission requests us to announce that examinations will be held for the positions of associate mechanical engineer with the engineering division of the Bureau of Architecture of the State Department of Engineering, and for the position of chief engineer with the same bureau. For the former position the entrance salary is $285 a month, which may be increased to $315. For the position of chief engineer the entrance salary is $360 a month with prospect of an increase to $380. Examinations will be held in Sacramento, San Francisco and Los Angeles as soon as possible after June 25, which date is the last day for filing applications.

Both of these positions have as their duties the design, construction and repair of the institutional buildings and structures of the state. Candidates must have had not less than four years in one case and eight years in the other of engineering experience, preferably mechanical.

Persons desiring to enter the examination may secure application blanks from the State Civil Service Commission at room 331, Forum building, Sacramento, or any office of the State Free Employment Bureau.

5,000 Miles of American Highway Building Annually

Reasonable prospect for spending $200,000,000 a year for construction and $20,000, for equipment every year in preparation for a new era of National development.

In a recent address to the executive board and guests of the Associated General Contractors of America, Past-President W. A. Rogers said in part:

There are in this country to-day approximately 2,500,000 miles of highways, of which about 50,000 miles might be developed into national or interstate routes or "Main National Routes." There are about 400,000 miles of highways which are state trunk lines and which lead into important centers and to and from important market points. I assume that eventually this 450,000 miles of highway will be improved in some form. There are now approximately 300,000 miles improved to a greater or less degree; approximately 45,000 miles are hard-surfaced, 15,000 of which are concrete, and the balance of the 300,000 miles are of gravel or similar form of surfacing . . .

I feel sure that in the near future we will be building 5,000 or more miles of concrete roads per annum. In order to get what this means intelli-

gently before us, I am presenting the following figures. For this purpose I have assumed the cost of $40,000 per mile. This would mean for 5,000 miles of highway approximately $200,000,000 expenditure per annum, the employment of about 100,000 men directly on the construction of this 5,000 miles for a period of about eight months, and the indirect employment in the manufacture and preparation of the materials entering into the construction of the highway of approximately an equal number of men, or a total of 200,000 men for a period of about eight months or an expenditure of $150,000,000 directly for labor per annum.

In addition, an investment in plant of sixty to eighty millions per annum is required to construct a program of this size, which investment would have to be renewed at least every four years.

It seems to be a fact that in the history of this country some form of construction has been the factor that has made possible the subsequent development of the country, for example, the construction of canals permitted the development of Ohio, construction of the railroads in the twenty years after the Civil War permitted the development, agriculturally, of the western country.

Often this development has seemed to be in advance of its need, but subsequent history has proved that the money has been well spent and that the rapid development of the country has only been made possible by this construction. It seems to me that we are facing an era of highway development comparable to the railroad development in the '70s and '80s. With the history of the past before us, and in view of the magnitude of work to be done, it is well to consider how the interests of the public may be best conserved in this work. . . .

If the better class of our contractors are to be induced to do this class of work, there are certain cardinal principles which must be adopted in connection with this work. Three of these principles I designate as Standardization, Stabilization, and Co-operation. Let me eplain.

We have in this country forty-eight states and each state has its different type of highway, different specifications as to materials and workmanship, different methods of payment and different types of organization for handling the owner's side of the work.

The contractor who gains his experience and adapts his plant for work in one state, has to remodel and recast his ideas for work in another states. Cost data gained in one state or even sometimes in one county of the state are not applicable without adjustment for another county or in another state.

Materials acceptable in one state may not be in another. The proportions of concrete materials are different. Take the one item of time of mixing the concrete. One state may require that the concrete be mixed a minute, another state a minute and a half to get the same results, when probably mixing half or three-quarters of a minute with a satisfactory machine would give equally good concrete. . . . By stabilization I mean that a definite program covering a period of years should be adopted. The investment in plant and organization for highway work is greater than that of almost any other contract work, in proportion to the volume of work. It is hardly reasnable to expect a large outlay for plant to handle this work will be made without reasonable assurance that it will be employed long enough in reasonably profitable work to justify the investment.

Definite programs of work should be adopted by the state or federal government covering a fairly definite amount of work to be done each year in the various districts for a period of years.

Refuse Disposal in London Boroughs

The problem of disposing of the refuse from the various boroughs in the metropolitan area of London is increasing greatly in difficulty and a committee has been appointed by a conference of the borough councils to consider the best methods to be adopted. This committee recently submitted a progress report setting forth existing conditions and tentative suggestions.

From this report it appears that the amount of refuse to be dealt with amounts to 1,500,000 tons a year. At the present time most of this is removed by barges or by rail to dumps in the outlying districts, where it constitutes a nuisance because of odors and of the rats and flies. Naturally the difficulty of finding new dumping sites increases yearly. The refuse not dumped is burned in destructors or is screened and salvaged. Prior to the war the cost of removing in barges averaged 62 cents a ton, but the cost now is about $2.25 a ton, the annual cost in one borough being nearly $250,000 last year (converted from English money on the basis of $5 to the pound). In most cases railway rates are higher than barge rates.

The suggestion had been made that a number of boroughs might combine for removing their refuse and acquire land for dumps by condemnation, but the committee believes that centralization would involve additional transport and dump difficulties without corresponding advantages.

The committee gives a preliminary opinion that it will probably be found most practicable to utilize the refuse, as is done in several cities, in some of which they found that salvaging actually produced an asset in relief of taxes. However, most of these salvaging schemes are still in the experimental stage and definite conclusions are not yet available.

Commenting on this editorially, the English Journal, "Municipal Engineering and the Sanitary Record," points out that: "If most local authorities screened and sorted the refuse it is highly probable that a glut of such salvage material as tins, rags and paper, which together constitute 5 per cent of the whole, would be created. At the present moment the demand for each of these classes of material is remarkably low, although efficient sales managers, such as those at Westminster, Marylebone and Sheffield, somehow find a market for them. It may mean that local authorities will find it necessary to establish factories or encourage establishments of factories

for their conversion into readily marketable products, as is the case in Belgium and Germany, as the quantities produced in London alone would be enormous. On the other hand, there will be a big reserve from cinders, which constitute 45 per cent of the screened refuse, whilst the fine dust, which constitutes 31 per cent of the total, should be readily disposed of to farmers." It is reported that Sheffield obtained a revenue of more than $15,000 for the year ending March 25, 1920, from its waste utilization, even before the screening plant had been installed.

Street Cleaning in Cincinnati

The decrease in working force led Superintendent Maag to adopt the use of machinery for sweeping and flushing, and for cleaning catch basins.

The annual report for 1920 of the Department of Streets, Sewer and Catch Basin Cleaning of the city of Cincinnati, by Fred Maag, the superintendent of the department, contains as usual a very complete statement of the amount of work done and the unit costs of the same for each of the several months and for each of the operations carried out. Cleaning and flushing are measured in terms of a "square" of 16,000 square feet as a unit.

Practically all costs were greater in 1920 than in 1919. For instance, the average flushing cost per unit increased from 13.1 cents in 1919 to 15.1 cents in 1920, the broom gang from 24.1 cents to 32.0 cents, etc. Overhead costs increased about 25 per cent, varying in the different operations from 19 per cent to 38 per cent. Most of the operations were less in volume for 1920 than for 1919, but in spite of this the total cost of all operations was about 20 per cent greater.

Probably the most interesting feature of this year's report is that dealing with the introduction in the department of labor-saving machinery. This was done largely in the interest of economy, and also because of the difficulty of obtaining labor. "For some time past the street cleaning department has been operating with a greatly reduced force, and this in face of the fact that the fewer men have now more streets to clean than ever before. The normal roster of employees contained 582 names: at the present time and even for a very considerable previous period we have been functioning with 320 men, including the sewer cleaning gangs and supervision of operations."

With work constantly increasing and working force diminishing, machinery seemed to be the only solution and correspondence was entered into with the leading manufacturers of street cleaning machinery. "Extended investigations, try-outs and practical demonstrations were witnessed and plans to motorize certain functional operations were set on foot." Tests of machines were made in the city itself and "the conclusion was reached that street cleaning by machinery must be one of the permanent adjuncts of the department, as the success of demonstrations was clearly proved to all who viewed the working of same."

Two pick-up street sweeper machines of Elgin manufacture were purchased, being the first of the kind ever seen in Cincinnati. It is stated that the machine can clean about 50 miles of street in eight hours, or 100 miles if the machine worked two shifts a day. "The sweeper has a small brush on the side that cleans out the gutters. This is followed by the larger or main brush about eight feet long, and the dirt and sweepings are thrown in a belt conveyor to a box carried on the front of the machine. This box when filled is then motored to a given point where the dirt is let out and carried away to the point of permanent disposal. The preliminary operation of these machines was such a pronounced success that we look into the future with great confidence and expectations of results to be achieved.

"The purchase of a suitable type of auto street flusher presented many perplexities to arrive at a decision on the class of machine that would be best adapted for the streets of our city. After much experimenting and observation, coupled with past experience, four of the most modern and improved auto flushers were purchased. Each carried 1,500 gallons of water, compared to 500 gallons carried by the old horse-drawn flusher. In the new apparatus the water is forced by the use of centrifugal pumps provided with special auxiliary motors. An even flow and constant pressure is thus provided by this means. In a single trip this machine can thoroughly flush a street forty feet wide, an accomplishment which was impossible with the old-style flusher." The machine purchased is a Studebaker flushing apparatus on a Pierce-Arrow chassis.

Both sweepers and flusher have been in use too short a time to enable Mr. Maag to give us any exact figures of the work performed or unit costs, but later we hope to be able to give such figures.

"The cleaning of sewers always presented a strenuous proposition, involving the actual entry of the workman into the basin in order to clean same by the old laborious hand method of filling the buckets, and withdrawing the same to the surface by windlass, operated also by hand by the men on the surface and then depositing same in the waiting wagon. This was the system pursued for years and years, and in line with progress our investigations proceeded to find if it were not possible to devise other and better means to facilitate basin cleaning, and without the necessity of the workmen going into the hole, as the basins were so called.

"In fact, it was becoming more and more difficult to hire men for this class of work, on account of this one objectionable feature, of having to go into the sewer to make the clean-out."

For this service a machine for pumping out catch basins was purchased from the Springfield Engineering Co., "and the results achieved have been all that was claimed and more. It is safe to assume that it will pay for itself in short order through the saving made over the old method of hand cleaning."

Paving Materials in Various Counties

Reports from hundreds of counties throughout the United States telling where contractors can obtain stone, gravel and sand that will be satisfactory to county engineers for use in concrete, macadam and gravel road construction.

(Continued from Page 459)

Palo Alto—A no, B no, C 60 or 70 miles, D yes, E yes, G yes.
Pocahontas—A one, B one, D yes, in parts of the county, E yes, H 25 miles.
Sac—A no, B no, C 150 miles, D yes, E yes, G yes.
Scott—A 5, B 5, D no, F 20 miles, G yes.
Tama—A none opened, C 14 miles, D no, E no, G yes.
Union—A no, B no, D yes, E yes.
Van Buren—A no, B no, C 50 miles, D not developed, E yes, F 50 miles to sand bank, G yes, if opened, H 50 miles.
Wapello—A none, B none, C 75 miles, D yes, E no, F 100 miles, G yes.
Warren—A no stone at all, B none, C 50 miles by R. R., D none at all, E one bar in river, F gravel 23 miles, G yes, if washed, H usually buy gravel, no economy to ship stone.
Webster—A no, B no, C 125 miles, D yes, E yes, G yes.
Winneshiek—A yes, B yes, C McGregor, Ia., D yes, E yes, F Claremont or Mason City, G yes, H Claremont or Mason City.
Worth—A no quarries, D lots of gravel, G yes.
Private Work—A no, D no, E no, F average 40 miles, G no, H average 40 miles.

KANSAS

Allen—A yes, B yes, D do not think so, E yes, G no, H 100 approximately.
Anderson—A yes, B yes, D yes, E yes, G none, H 90 miles to Kaw river sand.
Atchison—A yes, B no, D yes, but not economically, E yes, G river sand.
Barber—A no, B no, C 190 miles, D yes, several by screening, E yes, by screening, G rivers and streams full of it.
Barton—A no, B yes, C 25 miles, D yes, E yes, G yes.
Brown—A no, B no, C 30 or 40 miles, D none, E no, F 30 or 40 miles, G no, H 50 to 100 miles.
Butler—A yes, B yes, D yes, E yes, G no, H Wichita, Kan.
Cherokee—A yes, B yes, D waste from lead and zinc mines, E yes, G yes.
Clark—A no, B yes, D no, E yes, G yes.
Crawford—A yes, B yes, D no, E no, F next county west, G no, H all sand shipped from Kaw and Arkansas river points.
Elk—A plenty of limestone, B plenty, D very few, E few, river gravel used mostly for roads, G no, H Wichita 80 miles, Topeka 150 miles.
Finney—A no, B no, C 200 miles, D yes, E yes, G yes.
Geary—A yes, B yes, D no, E yes, G best quality from river bars.
Graham—A yes, B yes, D none, except crushed stone, E as above, G yes, banks and river.
Greeley—A no, B no, D 1, E 3, G yes, in abundance.
Harper—A none, B none, C 70 miles, D no, E yes, G yes.
Johnson—A yes, B yes, D yes, E yes, G yes.
Kingman—A none, B none, C 70 miles, D none, E none, F 100 miles, G yes.
Labette—A yes, B yes, D yes, E yes, G no, H sand must be shipped in.
Lyon—A yes, B yes, D yes, by washing, E yes, G limited amount, H 64 miles shipped.
Marion—A yes, B yes, D no, E no, F 60 miles, G no, H 20 miles.
McPherson—A no, some stone of fair quality, B none, D yes, E yes, G yes.
Meade—A no, B no, C 300 miles, D some, E some, G yes.
Mitchell—A yes, but not extra good, B no, C 35 miles from Beloit, D no, E no, F 15 miles from Beloit, G yes.
Montgomery—B yes, E yes, H 75 miles.
Nemaha—A no, C 75 miles, D no, F 30 miles, G no, H 30 miles.
Norton—A no, B no, D yes, E no, G yes.
Osage—A no, B possibly, D not desirable, E yes, millions of cubic yards well distributed, G no, H Kaw river Topeka 15 to 50 miles.
Pawnee—A no, B no, C 80 miles, D yes, E yes, G yes.
Russell—A yes, for bridges, D yes, E none, G yes.
Sedgwick—A no, B no, C 200 miles, D no, E no, F 65 miles, G yes.
Shawnee—A yes, B yes, D no, E yes, G no.
Smith—A yes, B yes, D no, E no, G yes.
Stafford—A no, B no, C about 150 miles, D yes, E yes, G yes.
Wabaunsee—A yes, B not very suitable, D no, E yes, G yes.

KENTUCKY

Allen—A none, B yes, D creek gravel, G creeg sand.
Barren—A all you want, B yes, D yes, G yes.
Bracken—A yes, B yes, D no, E no, G no, H shipped in 50 miles.
Carroll—A yes, B yes, D yes, E yes, G yes.
Daviess—A no, B no, C 55 miles, D no, E yes, G yes.
Fleming—A yes, B yes, D no, E yes, G no.
Gallatin—A yes, but not used, B surface, D plenty, E plenty, F all along Ohio river, G yes, H 10 miles.
Hopkins—A one just opened, B 40 miles, D no, F 40 miles, Go no, H 40 miles.
Mason—A no, B yes, D yes, G yes.
Montgomery—A not many, D no, E yes, G no.
Morgan—A yes, B no, C 50 miles, D yes, E yes, G yes.
Oldham—A yes, B yes, D no, E yes, G yes.
Owen—A 2, field limestone scattered over entire county, D no, E no, G no.
Pike—A yes, B bituminous, C limestone 110, D no, E no, F 110.
Rockcastle—A yes, B yes, D yes, E yes, G yes.
Shelby—A no, B yes, D no, E yes, G no, H has to be shipped 30 miles.
Whitley—A none, B none, C 36 miles, D none, E none, G none.

LOUISIANA

Avoyelles—A no, B no, C 50, D no, E no, F 50, G yes.
Caldwell—A no, B no, C 30 miles, D no, E no, F 30 miles, G no, H 30 miles.

MAINE

Knox—A yes, B yes, D yes, E yes, G yes.

MARYLAND

Kent—A none, B none, C 50 miles, D none, E 50, G 50.

MASSACHUSETTS

Athol—A yes, B yes, D yes, E yes, G yes.
Essex—A yes, B yes, D yes, E yes, G yes.
Middlesex—A yes, B yes, D yes, E yes, G yes.

MICHIGAN

Alger—A yes, B yes, D no, E yes, G yes.
Cass—A no, B no, C 125 miles, D yes, E yes, F 2 miles, G yes, H 3 miles.
Dickinson—B yes, D yes, E yes, G yes.
Eaton—A no, B no, C 150 miles, D yes, E yes, G yes.
Emmet—B yes, D yes, E yes, G yes.
Grand Traverse—D yes, E yes, G yes.
Kalkaska—A no, D yes, E yes, G yes.
Lapeer—A no, B no, D yes, E yes, G yes.
Luce—A yes, B yes, D yes, E yes, G yes.
Macomb—A no, B no, C 40 miles, D yes, E yes, G yes.
Mason—A no, B no, C 100, D no, E yes, F 60 miles, G yes.
Missaukee—A no, B no, C 50 miles, D yes, E yes, G yes.
St. Joseph—A none, B none, C 80 miles, D yes, E yes, F several in county, G yes, H several in county.
Washtenaw—D yes, E yes, G yes.

MINNESOTA

Aitkin—D yes, E yes.
Big Stone—A yes, B yes, D yes, E yes, G yes.
Blue Earth—A yes, B yes, D yes, E yes, G yes.
Brown—A no, B no, C 3 miles, D yes, E yes, G yes.
Carlton—D yes, E yes, G yes.
Carver—A yes, B yes, D yes, E yes, G yes.
Chippewa—A none, B none, C 100 miles, D very few, E yes, F on roadside, G yes, H 6 miles from nearest R. R. point.
Chisago—A yes, B yes, D yes, E yes, G yes.
Cottonwood—A none developed, but plenty of rock, C 60 miles, D yes, E yes, but they vary, G yes, but limited.
Dodge—A yes, B yes, D yes, with screening, E yes, G yes.
Faribault—A no, B no, C 40 miles, D no, E yes, F 40 miles, G no, H 40 miles.
Goodhue—B yes, D for building, but not concrete road surface, E yes, G yes.
Grant—A no, B no, C 70 miles, D yes, E yes, G yes.
Hubbard—A none, B none, C unknown, D yes, E yes, G yes.
Isanti—A no, B no, C 50 miles, D no, E yes, F 50 miles, G no, H 50 miles.
Jackson—A none, B none, C 100 miles, D large number, E lots of gravel, G quite a few.
Kandiyohi—A no, B no, C St. Cloud, 66 miles, D yes, E yes, G yes.
Lac Qui Parle—A yes, B yes, D very limited, E yes, many, G some.
Lincoln—A no, C about 15 miles, D yes, E yes, G yes.
Lyon—B none, C Jasper, Minn., D yes, E yes, G yes.
Marshall—A no, B no, D yes, E yes, G yes.
Martin—A no, B no, C Mankato, Minn., D no, E yes, G no, H Mankato.
McLeod—A no, B no, C 60 miles, D yes, E yes, G yes.
Millelacs—A no, B no, C 35 miles, D yes, E yes, G yes.
Nicollet—A yes, at Red Stone, B yes, same as A, C 3 miles at Kasota, D yes, many, E yes, many, G yes, many, H good gravel and sand found along the Minnesota river.
Nobles—A none, B none, C 40 miles, D no, E yes, G few.
Pine—A yes, D yes, E yes, G yes.
Pope—A no, C St. Cloud, 60 miles, D great number, E on every road, G a number.
Redwood—A yes, D no, E yes, G yes.
Roseau—A yes, one, B one, D yes, the county owns 10 pits, E yes, G yes, in all gravel pits.
Stearns—A yes, B no, D yes, E yes, G yes.
Steele—A no, B no, C 16 miles, D yes, E yes, G yes.
Stevens—A none, D yes, G yes.
Swift—A none, B none, C 60 miles, D yes, E yes, G yes.
Wadena—A none known by highway engineer, B none, C St. Cloud, D yes, E yes, G yes.
Winona—A yes, B yes, D yes, E yes, G yes; Note: There are 3 large commercial sand and gravel companies in Winona.

MISSISSIPPI

Adams—A no, B no, D yes, in stream beds chiefly, E yes, G yes, in stream beds chiefly.
Benton—A no, B no, C 60 miles, D no, E no, F 60 miles, G yes, H 60 miles.
Lafayette—A none, B none, C 60 miles, D no, E no, F 40 miles, G yes.
Lee—A none, B none, C 80 miles, D none, E none, F 20 miles, G none, H 20 miles.
Lincoln—A no, B no, C 200 miles, D a washed gravel plant in county, E yes, numerous, G no, H washing plant in county.
Lowndes—A sand-gravel, B red clay gravel, D yes, E yes, G yes.

MISSOURI

Butler—A none developed, D gravel bars in rivers, E yes, G no.
Caldwell—A many, B yes, D no, G yes, in streams.
Carter—A yes, D yes, E yes, G yes, but limited.
Cedar—A no, B no, C not known, D yes, E yes, G yes.
Clark—A none, B none, C 25 miles, D none, E none, F 30 miles, G yes.
Cooper—A yes, B yes, D some, E no, F 200 miles, G yes.
Henry—A none tested, B none tested, D none, F about 30 miles, G none, H Missouri river shipped from Kansas City.
Lincoln—A yes, B yes, D yes, E yes, G yes.
Macon—A very few, B few, C about 70 miles, D none, E none, F about 70 miles, G none first quality, H Mississippi river, 70 miles.
Mississippi—A none, B none, C 35 to 45 miles to satisfactory quarries, D no, E no, F 40 miles, G no, H 40 miles.
Monroe—A splendid limestone in abundance, B plenty of it, a little soft, D small deposits along streams, E not enough to go for, G yes.
Ozark—A yes, B yes, C stone everywhere, D yes, E yes, F in all creek beds, G yes, H on all larger streams.
Perry—A yes, many, B yes, many, D along most streams, E yes, along streams, G yes, many.
Putnam—A no, B no, D no, E no, G yes.
Ralls—A yes, B yes, D yes, E yes, G yes.
Schuyler—A none, B none, C 80 miles, D none, E none, F 80 miles, G none, H 70 to 80 miles.
St. Claif—A yes, limestone, B yes, C all along Osage river, D yes, E yes, F Osage river, G yes.
Sullivan—A yes, D none, G yes.

MONTANA

Beaverhead—A yes, B yes, D yes, E yes, G yes.
Big Horn—A no, B no, D yes, E yes, G yes.
Blaine—A no, B no, D no, E yes, G yes.
Carbon—A deposits for gravel, all parts of county for concrete, B large deposits, D many, all parts, E many, G by screening.
Chouteau—A none, B none, D few only, E few, G yes.
Fergus—A no, D in western part of county, E same as D, G yes.
Flathead—A yes, B yes, D yes, E yes, G yes, H yes.
Granite—A no, but much rock is available, B plenty of rock, D yes, E yes, G yes.
Hill—A no, B no, C 200 miles, D yes, E yes, G yes.
Madison—A Rocky mountains, B yes, abundant supply, D no part of county more than 5 miles from known supply, E yes, G yes, considerable number.
Meagher—A yes, B yes, D yes, E yes, G yes.
Musselshell—A no, B no, D not for road purposes, E yes, but poor quality, G not for concrete roads, H must be shipped in on R. R.
Prairie—A none in operation, D number of gravel deposits for concrete and road surface, F well scattered over county, G yes, H well distributed.
Stillwater—A no, D yes, E yes, G yes.
Teton—A no, B yes, D yes, E yes, G yes.
Valley—A no, B no, C plenty surface rock everywhere—granite, D yes, E yes, G not of the best.
Wheatland—A yes, D yes, G yes.
Yellowstone—A yes, B yes, D yes, E yes, G yes.

NEBRASKA

Antelope—D yes, lots of them, G yes.
Dakota—A no, B one, C 60 miles, D yes, E yes, by crushing, G yes.
Deuel—A no, B no, C don't know, D yes, E yes, F 1 to 3 miles, G yes, H 1 to 3 miles.
Hooker—A none, B none, D yes, E yes, G yes.
Knox—A no, B no, C don't know, D yes, E yes, G yes.
Morrill—A no, B no, D yes, E yes, G yes.
Otoe—A no, B no, C 35 miles, D no, E no, F 35 miles, G yes.
Rock—A yes, B yes, D yes, E yes, G yes.
Saline—A no, B none, C 40 miles, D no, G yes, H all kinds of sand.
Sherman—A yes, some, D yes, E no, F 100 miles, G yes.
Wayne—A no, B no, C Minnesota or lower Nebraska, D no, E no, F 35 miles, G no, H all shipped by rail 100 miles.

NEW JERSEY

Burlington—A no, B no, C 40 miles, D yes, E yes, G yes.
Cumberland—A yes, B no, C 55 miles, D yes, E yes, G yes.
Hunterdon—A yes, B yes, D no, E no, G nothing of any size.
Mercer—A 4, B 4, D yes, E yes, G yes.
Passaic—A 7, B 7, D yes, E yes, G yes.
Southern Division—A yes, B no, C throughout the district, D yes, G yes.
Sussex—A yes, B yes, D no, E yes, F sand concrete 11 miles, G no, H 11 miles.
Union—A yes, B yes, D no, E no, F 30 miles, gravel not used in this county, G no, H 25 miles.

(*To Be Continued*)

Construction Questions Answered

Suggestions as to methods, "wrinkles" and appliances that may be used to overcome difficulties arising in construction work. We invite questions concerning such problems that may arise from time to time in the experience of any of our readers. Answers prepared by competent authorities will be published promptly. It is hoped that others who have solved similar problems differently will send us their solutions for publication also; or describe new "wrinkles." If it is only a new way to drive a nail, it may help some one.

LINING a 20 Foot Well, 50 Feet Deep

Important factors influencing design and operations that require engineering services. General practice in making and placing lining, built monolithic or sectional, resistance to sinking, concrete forms, ballast, methods of excavating, provision for difficulties, underpinning, jetting and sheet piling.

May 12, 1921.

Editor, PUBLIC WORKS.

Dear Sir: We are contemplating the digging of a new city well, this well will be 20 feet inside diameter and 50 feet deep, we intend to curb it with reinforced concrete and use an orange-peel bucket for excavating and sink the curbing with the excavation, the well is to be covered with reinforced concrete.

Will you kindly give me the information necessary for the design of this curbing, showing the thickness of wall and size of steel and distance apart. I am enclosing addressed stamped envelope for reply and thank you very much for your reply.

Yours truly,

———

Superintendent.

Your letter of May 12 does not give sufficient information for a detailed answer to your question. The thickness of the lining for the well and its reinforcement depend upon several important factors, including the purpose for which the lining shall serve after the completion of the well, the material through which it is to be sunk, and the method by which it is to be sunk.

REQUIREMENTS

If the lining is to serve as the foundation to support a heavy superstructure or to carry machinery, or is to be subjected to vibration or impact, or must be perfectly waterproof, or is to have openings through the sides, these features must be considered in its design.

If the character of the material through which it is to be sunk is unknown, explorations should be made by preliminary borings to determine what is likely to be encountered, and if they are not made, the curb or lining must be constructed with an excess of strength and rigidity to resist hardship in sinking. So far as sinking alone is concerned, a thin, light cylinder might suffice for passing through soft mud that would not answer for more difficult materials, nor be able to withstand the heavy stresses developed if it encounters irregular strata, logs, timbers or boulders.

It must in any event be designed to resist the heavy, unbalanced external pressure and a possible unbalanced internal pressure if it should be filled with water and the ground outside should be dry. It may require a heavy steel or reinforced cutting edge, or a very light one may suffice.

If the excavation is such as can be entirely accomplished by a dredge bucket it should not endanger the integrity of the lining, but if serious obstructions are encountered they may require undermining, heavy chisel work, or even blasting or divers' work, and it may be necessary to undercut the lower edge of the cylinder.

ENGINEERING ADVICE NECESSARY FOR DESIGN

Unless the cylinder is of extraordinary weight, and perhaps not then, its weight alone will not suffice to sink it to the full depth and additional ballast must be provided or supplementary devices like hydraulic jets or compressed air be used to diminish the heavy friction.

The design is therefore a subject that involves careful investigation, study and expert experience which can be properly furnished only by an engineer retained for this purpose. Similar qualifications are necessary for safely and economically executing the work after it is designed. Such services can best be procured from engineers and contractors who specialize in this class of construction, many of whom are members of the principal engineering societies and whose names are found in the advertising pages of the principal technical journals.

PUBLIC WORKS is very glad and ready to give general information or explain novel and standard methods of executing work, but cannot, of course, undertake to make engineering designs for specific cases, or to make investigations and give expert advice that are in the province of the consulting engineer.

INTERIOR EXCAVATION AND UNDERMINING

If the well is for a water works intake, condensation water supply, or other purpose that requires it to be built, as is sometimes the case, in the bed of a lake or river, operations will have to be carried on inside a cofferdam which may often be adapted from the lining itself. It may be wholly or partly built on shore, launched and floated to position and sunk by interior excavation and loading.

If the well is on shore and the ground is very wet it is sunk in much the same way, but without

the use of any cofferdam except what is afforded by the lining itself. Usually it will be possible to "ditch" the lining, that is, to excavate for it in the open down to a little below ground water level, or as far as can be comfortably pumped out, and then build the lining in the bottom of the pit, allowing it to sink by its own weight as the core is excavated by a dredge bucket working under water, as is apparently indicated in the inquiry. For such operations the lower part of the wall should be chamfered on the inside to a very narrow external edge so as to allow the bucket to work as far under the wall as possible and to facilitate the fall of the earth from the exterior under the cutting edge. If, however, local conditions are such as to make any undermining or settlement of the adjacent surface objectionable, this method must be avoided and pains taken to excavate only as much material as is actually displaced by the lining.

If no obstructions are encountered and an orange-peel or clam-shell bucket is used for the excavation, there will be no particular difficulty in excavating below the surface of the water, and considerable advantage will be gained by allowing the water to remain undisturbed in the well during excavation, thus saving the expense of pumping and, in case of encountering quicksand, preventing the development of unbalanced pressure that might cause a large inflow of quicksand and necessitate removing a great deal more spoil than required by the actual volume of the well. If serious obstructions are encountered and it is practicable to pump out the well, it should be done so that men may enter and remove the obstructions; otherwise, the removal by divers and by cutting or blasting under water is likely to be difficult, slow and expensive. Soft material can be removed by a clam-shell bucket; harder material, together with boulders and small timber, even hardpan, can be excavated by a heavy orange-peel bucket. Sand or mud can be pumped out if a suitable centrifugal pump is conveniently available.

SKIN FRICTION AND BALLAST

As the concrete lining proposed may weigh 500,000 pounds and as its descent is opposed by skin friction amounting to perhaps 1,500,000 pounds or more, there may be required 1,000,000 pounds ballast to sink it, an amount which it is likely to be difficult to secure and costly to handle conveniently. The amount of skin friction and consequently the amount of ballast is inversely proportioned to the depth of the open pit in which the sinking is commenced, and it can be cut in half by sinking the lining in two successive sections, a process which requires that the interior diameter of upper section should be somewhat greater than the exterior diameter of the lower section. When this method is employed the lower section can be commenced first and sunk until its upper edge is level with the bottom of the dug pit, after which the upper section can be sunk concentric with it, the material between the two sections washed out with hydraulic jet, and the sinking of the lower section resumed with the elimination of initial skin friction.

The most convenient ballast for loading the lining is generally rails, pig iron, or the like, and special arrangement must be made to apply a large quantity of it without obstructing the dredging operations in the interior.

HYDRAULIC JETS

In sand, loam, or gravel, sinking can be facilitated by providing powerful hydraulic jets around the cutting edge both on the inside and on the outside. In soft materials, if these are numerous and powerful enough they may alone suffice to sink the shell under its own weight to a considerable distance without interior excavation, the core being removed afterwards when it may be possible to seal the bottom, pump out and excavate in the dry.

If the concrete lining is built up to the full height before excavation is commenced, its great weight will expedite the sinking at first, and the operations can be more rapid and continuous throughout. If this is not possible, the shell can be built from the bottom up in successive rings or courses of any convenient height. In either case, steel or wooden forms of the most convenient and economical type can be selected and should be from 5 to 10 feet high, with the outer and inner walls connected by detachable tie rods. They should be slipped up in successive stages with the lower part always engaging the hardened concrete so as to automatically center and support the upper portion for each successive course.

DRY EXCAVATION

If the soil is hard and dry, the orange-peel excavation may be supplemented or replaced by hand work. Obstructions can be removed and the earth excavated under the cutting edge much more advantageously than if the pit is filled with water. If the earth stands up well without disposition to cave in or bleed around the sides of the excavation, it may even be possible to carry the excavation several feet below the lower edge of the concrete lining and to build the concrete lining in successive rings or sections in the bottom adjoining the portion already built, thus underpinning it with course after course. This method is not as desirable as the construction on top so long as the lining sinks freely, but if the friction becomes so great as to stop the sinking, the lower lining can sometimes be advantageously built in this manner.

In very firm soil, such as solid clay, the excavation may sometimes be wholly made before the permanent lining is built, the sides being sheeted and braced temporarily if necessary, and serving as an exterior form against which the concrete can be placed around an interior form only, after the excavation is wholly or partly completed. In such cases the thickness of the lining and its reinforcement would probably be required to be proportioned only to resist unbalanced pressures.

PNEUMATIC CAISSON WORK

If there is possibility of encountering interior obstructions and a large amount of water at a considerable depth and it is necessary to secure access to the bottom of the well, provision should be made in the lining for the application, if necessary, of air pressure to enable the job to be com-

pleted by the pneumatic caisson method. This can be done by leaving recesses in the inner face of the wall about 6 feet above the lower edge, or by building a reinforced annular shoulder there, to take bearing against beams supporting an air-tight deck that can be installed, even under water if necessary, and fitted with an air lock permitting air pressure to be forced in and the work to be completed in the working chamber under the deck. This method should only be used in case of necessity, but preliminary provision for it is very simple and inexpensive. The great objections to this method are the cost of the installation and removal of the air compressing machinery, the delay, and the expensive nature of caisson work. It is, therefore, a method to be used only as a last alternative and is seldom unavoidable.

LINING EXTENDED FROM THE BOTTOM

If by excavating and loading the lining is sunk to clay, hardpan or other hard stratum and will not descend farther, it may sometimes be sealed and permanently supported there and excavation continued to the required depth over the whole area at once, or if necessary in successive sections, and the remainder of the lining built in as a unit, or in courses or sections under the integral upper portion. If much ground water is encountered or the vertical sides of the excavation are unstable, they may be supported by driving slightly inclined poling boards or steel or wooden sheet piling around the circumference with an air hammer or by hand as the core is excavated.

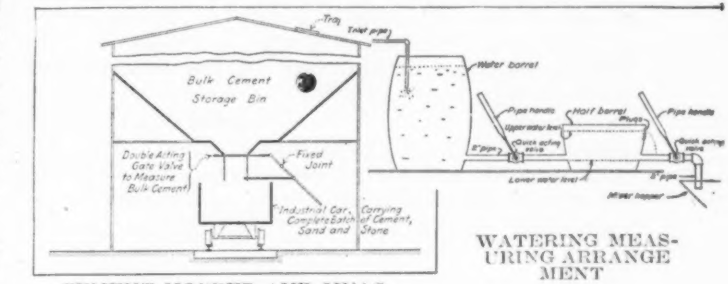
Delivering Bulk Cement and Water to a Concrete Mixer

Recent articles in the "Contractor's Atlas" describe simple and efficient methods of measuring and delivering bulk cement and water to a concrete mixing machine, thus enabling the contractor to expedite and economize the work at the same time that great accuracy was secured without additional trouble. It was found cheaper to unload bulk cement than cement bags, and appreciable losses in bags, and in cement adhering to them, and the cost of transportation of the empty bags were saved by purchasing the cement loose in carload lots for the pavement of more than 5 miles of the Franklin-Isaac concrete road in Virginia.

The cement was transferred from cars to the storage bin by a 36-foot belt conveyor, hooked to the floor at the bottom of the car door. Two men in the car shoveled the cement to the conveyor and handled twice as much cement as six or eight men unloading with wheelbarrows.

The hopper bottom storage bin was provided with a double acting gate valve shown in the sketch, each movement of which measured and discharged exactly 3 bags of cement to the batch box in which the required amount of sand or broken stones had previously been placed.

A simple method for quickly delivering an accurate amount of water to the mixing machine is also shown in the accompanying diagram of an arrangement suited to a limited supply, or where the water is received slowly and there is no regular measuring tank attached to the mixer. The water may be received in a barrel or other convenient reservoir with an overflow or governed by a float valve, and flow from this reservoir through a short large pipe to the measuring tank provided with a number of small holes half an inch apart vertically, all but one being filled with plugs that are changeable to permit the water to escape at any required height, thus forming a tell-tale to indicate as soon as the tank is filled.



WATERING MEASURING ARRANGEMENT

CEMENT HOPPER AND MEASURING VALVE

The inlet and outlet pipes are fitted with quick opening valves with long lever handles and when these are set to operate in opposite directions and connected by a pivoted bar, not shown in the sketch, so that one valve is open when the other is closed and vice versa, they can both be instantaneously operated at a single motion and the water delivered to the mixer as soon as the aggregate is placed in the hopper, afterwards the valves remain in this position and are reversed just as the next batch is ready when they are moved back and forth and the operation repeated, and so on.

Sugar Beet Sap Destroys Concrete Roads

Much has been written about the effect of traffic of various kinds, of frost and of other agencies in destroying pavements of different kinds of materials, but from the west comes news of a new source of damage to concrete pavements. In sections where sugar beets are grown in quantity and are transported over the roads to factories it has been found that the sap or juice from the beets is decidedly injurious to concrete pavements. About two years ago County Commissioner William B. Hughes, at Salt Lake City, Utah, was informed by the vice-president of a sugar company in Ogden that "beet pulp juice dripping from wagons is very injurious to concrete roads. Concrete road at Loveland factory of the Great Western Sugar Company was ruined by this means." Similar trouble was experienced at Fort Collins, Colo., and last September the city passed an ordinance providing that "all persons or corporations are hereby prohibited from transporting beet pulp over, across or upon any paving districts or streets within the corporate limits of the city of Fort Collins, or allowing any beet wagons to stand upon said pavements or streets when loaded with beet pulp; providing beet pulp may be transported over, upon and across the streets of the city of Fort Collins when carried in water-tight wagons and not overloaded and the owner and operator of said wagon or wagons has a certificate to that effect from the commissioner of public works of the city of Fort Collins."

Recent Legal Decisions

WATER RATES FIXED BY ORDINANCE SHOULD YIELD REASONABLE RETURN ON INVESTMENT

The California Supreme Court holds, Union Hollywood Water Co. v. City of Los Angeles, 195 Pac. 55, that an ordinance fixing a water rate which would only allow a return to the water company of 1.27 per cent on its capital investment would be in violation of the federal and state constitutions, prohibiting the taking of private property for public use without due compensation and without due process of law. The testimony with respect to the amount that should be allowed as a reasonable rate of interest on investments of this character placed it at from 6 to 8 per cent.

DISCRIMINATION TO CUSTOMER BY ALLOWING FAILURE TO PAY BILLS PROMPTLY

In granting an increase in water rates to the City Water Plant of Fayetteville, Ark., the Arkansas Corporation Commission says: "Like most municipally owned plants, it is operated by a commission appointed by the city council, who do not devote their whole time to the management of the plant. For this reason there is no doubt a looseness in the management of the plant. Especially is this reflected in the evidence before the (Corporation) commission, which shows that various patrons of the plant are several months in arrears in the payment of their water bills, one user, at least, having gone fourteen months without paying his bill. The rules on file with this commission, and the general policy of the commission, is to require prompt payment of all outstanding bills owing to a utility. It is necessary in order to prevent discrimination that these rules must be rigidly enforced. The rules filed are as much a part of the rates as the amounts fixed therein. To allow one customer to violate the rules by not paying his bill promptly is as much discrimination against the other consumers as to give to one customer a lower rate than that fixed by the commission."

COMPETITION BY MUNICIPAL LIGHTING PLANT

A petition by a public utility company showed that the petitioner was the owner of the gas plant in the town of Burlington, Colo., and complained to the Public Utilities Commission that the municipality had, under an ordinance providing for a bond issue for the purpose of extending the water system of the town, constructed and put into operation an electric light plant, and was in competition with the petitioner in the matter of furnishing light. The petitioner claimed that the town had not complied with the statute of 1917, which requires that a public utility shall thereafter obtain from the commission a certificate that public convenience and necessity require the exercise of the right or privilege claimed by the utility. As it appeared from the evidence before the commission that work on the municipal lighting plant was begun before the law became effective, the Colorado Supreme Court, Burlington Gas & Electric Co. v. Commission, 194 Pac. 367, held that the commission's finding in favor of the town was justified.

OWNER JOINING IN PETITION FOR CHANGE OF GRADE STOPPED FROM CLAIMING DAMAGES

The Mississippi Supreme Court holds, Adams v. City of Vicksburg, 86 So. 855, that where an abutting owner signs a petition requesting the city "to grade the street to proper lines and grades," and the city so grades it properly, without objection, the owner is estopped from claiming damages, because the request authorized a change of grade, if proper to make it, and the owner thereby waived his constitutional right to damages.

REGULATING SUPPLY OF WATER TO TENANTS IN BUILDING

In a suit to compel a water company to supply the tenants of a building with water the Vermont Supreme Court holds, Waldron v. International Water Co., 112 Atl. 219, that where there is no general state statute conferring authority to a water company to refuse to deal with tenants of promises which it is under obligation to supply with water, and where the city charter requires the water company to furnish water to the "inhabitants" of the municipality upon terms of equality, the water company has no power to make a regulation requiring owners to pay for water used by tenants and to refuse to sell to tenants. But it is also held that the right of the individual tenant to be supplied with water is qualified by a duty not only to pay or tender the rent charge but also to provide proper means of conveying the water to the tenement occupied by him. The water company's possession ends at the service line, and it cannot be required to provide pipes extending through private property to the several apartments of the block. The water company is entitled to exclusive control of the service pipes at the point of distribution, so that it can supply a tenant who pays his rent without being compelled to supply others who do not pay. In the absence of some materially satisfactory arrangement respecting the means of supply, a tenant demanding water for the portion of the premises occupied by him should bring his own service pipes to the street line. But where the water company has rendered a service to the tenants in a block through a one-pipe system since its inception seven years before without objection, though it could at the outset properly have declined to supply the tenants through a single pipe, the law will imply an agreement to continue the service, at least until such time as by a proper and reasonable regulation it should call upon all its patrons without discrimination to change the means of supply.

NEWS OF THE SOCIETIES

June 13—AMERICAN FEDERATION OF LABOR. Albany Hotel, Denver, Colo.

June 13-14—CLEVELAND SECTION AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Regional meeting, Great Lakes Territory. Hotel Statler.

June 14-16—NATIONAL FIRE PROTECTION ASSOCIATION. Annual meeting. San Francisco.

June 15-16—TRI-STATE WATER AND LIGHT ASSOCIATION. Asheville, N. C. Secretary, W. F. Seitglitz, Columbia, S. C.

June 15-17—LEAGUE OF MICHIGAN MUNICIPALITIES. Annual Convention. Kalamazoo, Mich.

June 17 — PHILADELPHIA SECTION, AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Outing at Howard McCall Field.

June 17—INLAND EMPIRE SECTION, AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Joint meeting with engineering societies of Spokane.

June 17—LOS ANGELES SECTION, SOCIETY OF MECHANICAL ENGINEERS.

June 20—AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Salt Lake City.

June 20-24—AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. 13th semi-annual meeting. Detroit, Mich.

June 20-24—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting. Asbury Park, N. J.

June 21-24—AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Joint annual and Pacific Coast convention. Salt Lake City, Utah.

June 28 — ATLANTA SECTION, AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Election of officers. Georgia School of Technology, Atlanta.

June 28-July 1 — SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, UNIVERSITY OF PITTSBURG. Annual convention. New Haven, Conn.

July 15—NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS. Annual meeting. Crown Hotel, Providence, R. I.

Aug. 10-12—INTERNATIONAL ASSOCIATION OF STREET CLEANING OFFICIALS. Annual conference. Hotel La Salle, Chicago, Ill

Sept. 13-16—NEW ENGLAND WATER WORKS ASSOCIATION. 39th annual convention. Bridgeport, Conn. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Sept. 28 (10 days)—NEW YORK ELECTRICAL EXPOSITION. Seventy-first Regiment Armory, New York City.

Oct. 11-14—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Annual Convention, Atlanta, Ga. Hotel Ansley. Secretary, James J. Mulcahey, Municipal Building, Denver, Colo.

Oct. 24-28—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Southern Hotel, Baltimore, Md. Secretary, Charles Carroll Brown, Valparaiso, Ind.

Nov. 14-18—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. New York City.

DETROIT ENGINEERING SOCIETY

Joint meeting with Detroit Section of the American Society of Mechanical Engineers and the Detroit-Ann Arbor Section of the American Institute of Electrical Engineers. Address by Messrs. Galusha and Clarke, of Dwight P. Robinson & Co., New York, engineers for the new Colfax plant of the Duquesne Light Company, of Pittsburgh, on "A Mine-mouth Super Power Station," illustrated with lantern slides and moving pictures. Detroit Board of Commerce rooms at 8 p. m.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Annual spring meeting, with sessions of the Forest Products, Fuel, Machine Shop, Management, Materials Handling, Power and Railroad Divisions and General Sessions. At Congress Hotel, Chicago. Preceded by inspection on May 21 of McCook Field, Dayton, and followed on May 27 and 28 by trip to Rock Island Arsenal.

ROCHESTER ENGINEERING SOCIETY

Group meeting. Joseph F. Brightman, local representative of C. A. Dunham Co., will talk on "Steam Heating Systems," illustrating his lecture with lantern slides. Rochester Engineering Society rooms at 8:15 p. m.

BROOKLYN ENGINEERS' CLUB

At the regular meeting May 19, the General Sales Tax, now pending before Congress with special reference to its bearing on the engineering profession was discussed by Judge L. R. Wilfley, former attorney-general of the Philippines.

At the meeting of May 26 the topic presented was "Meters" from the standpoint of the city engineer, the legislator, the executive, the Lockwood committee, the district attorney and the public, and the establishment of government standards and codes for all materials and appliances was discussed.

ENGINEERS' SOCIETY OF PENNSYLVANIA

The Engineers' Society of Pennsylvania has elected the following officers for the coming year: President, Richard V. McKay; vice-president, Theodore E. Seelye; second vice-president, Crosby Tappan; directors, W. S. Baldwin, Fred Harry and R. Boone Abbott; secretary, Howard E. Moses; and treasurer, Harry T. Neale.

ENGINEERS' CLUB OF PHILADELPHIA

William F. James was elected president of the Engineers' Club of Philadelphia by a majority of 193 votes. He defeated Morris L. Cooke, who had been the choice of the nominating committee. Other officers elected were: vice-president, C. N. Lauer; treasurer, Clayton W. Pike; and directors, Herbert B. Allen and Henry F. Sanville.

AMERICAN SOCIETY OF CIVIL ENGINEERING

At the regular business meeting on June 1, at the rooms of the society, Engineering Societies building, New York City, "A Model Engineer Viewed as a Superior Mechanism" by S. Bent Russell was supplemented by the discussions of C. J. Tilden on "Engineering Ethics"; Rudolph Hering on "Age Improves the Quality of the Model Engineer"; Milo S. Ketchum on "The Professor of Engineering as a Model Engineer"; R. S. Parsons on "The Executive Can Be a Model Engineer"; J. W. McConnell on "The Contracting Engineer Can Be a Model Engineer"; John M. Goodell on "The Engineering Editor Can Be a Model Engineer."

PERSONALS

White, G. S., has recently been appointed city engineer of Fort Morgan, Colo.

Wade, G. R., has resigned as county engineer of Cherokee county, Texas, and R. Y. Watson appointed to his position.

Cassin, H. B., has resigned as assistant engineer of Jefferson county, Ky.

Brooks, Clarence M., has resigned as division engineer of the New Hampshire State Highway Department to become highway commissioner of Vermont.

Moss, W. E., has been appointed city engineer of Mt. Vernon, Wash.

Shoemaker, H. P., for eleven years city engineer of Lock Haven, Pa., has resigned to enter private engineering practice.

Clark, B. E., recently acting state engineer of Oklahoma, has now been appointed acting state highway commissioner.

Read, L. C., Jr., has been reappointed city engineer of Sandusky, Mich.

Cooper, W. C., has been appointed city engineer of Kalispell, Mont.

Talbot, W. R., is now engineer for the good roads committee of the Chamber of Commerce, Danville, Va.

Sneed, John L., has been appointed resident engineer for the Virginia State Highway Commission with headquarters at Richmond.

Brown, Norman F., has been appointed director of public works, Pittsburg, Pa., to succeed John Swan, resigned.

Alderman, Ernest S., has been appointed state engineer of Oklahoma.

Tinkham, Samuel E., since 1874 connected with the engineering and public works departments of Boston, died on April 21.

Stanley, George L., has been appointed city engineer of Burlington, Vt.

Kemmish, N. A., has been made city manager of Alliance, Neb.

Edwards, Athol B., of New York City, has been appointed city manager of St. Albans, Vt.

Burley, Ralph J., assistant director and chief engineer of the Reclamation Service in the Department of the Interior, Ottawa, died on April 14.

McCamy, C. C., has been appointed city engineer of Dalton, Ga.

Ford, E. P., has been appointed city engineer of East San Diego, Cal.

Gilmer, D. E., has resigned as county engineer of Reno county, Kan.

McElherne, J. C., has been appointed engineer for Rice county, Minn.

Coleman, Dwight B., has resigned as county superintendent of highways of Cortland county, N. Y.

Robertson, J. D., engineer of highways, Alberta, has been appointed deputy minister of public works.

Parker, G. C., has recently undertaken the duties of acting secretary of the Department of Highways, Ontario.

MacPhee, Neil B., has recently been appointed town superintendent of Port Dalhousie, Ont., to take charge of the water works system.

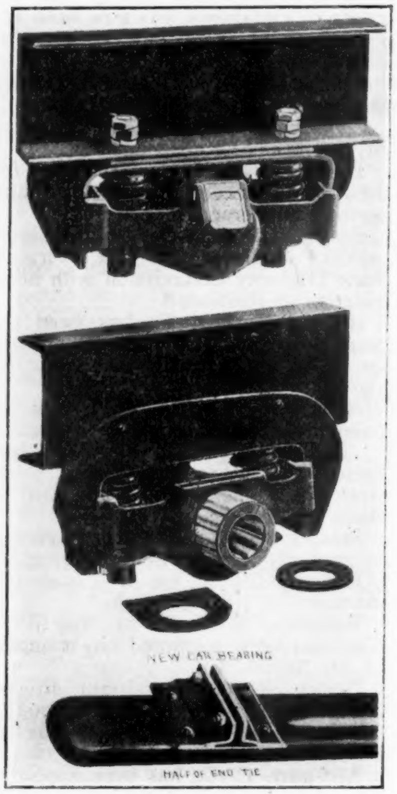
Schneider, Delmont J., has been appointed city engineer and street commissioner of Pocatello, Idaho.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

KOPPEL INDUSTRIAL TRACK AND EQUIPMENT

The Koppel Industrial Car & Equipment Company has put on the market improved sectional industrial railroad track made with 20 and 25-pound standard rails 15 feet long riveted to pressed steel channeled ties with ribbed webs, giving them great stiffness. The end ties have pairs of angle clips riveted to them, giving support to both the webs and the flanges of the rails and provided for bolting the track sections together. The ties are 3½ feet long and 5 inches wide. Several miles of this track are in use by G. P. Scharl, Muskegon, Mich.



PEDESTAL FOR TRUCK WHEEL AXLES

The Koppel Company has also devised a new pedestal bearing for the axles of the wheels in trucks used for the transportation of batch boxes. This pedestal contains a roller bearing, and bolted and riveted to the frame. The trucks can be used not only to carry batch boxes, but also can receive the standard for tilting bodies that transform them into side dump cars.

CRAWLING TREAD LOCOMOTIVE CRANES

The 7 and 12-ton crawling tread locomotive cranes, manufactured by the Orton & Steinbrenner Company, are small machines capable of performing all the functions of large standard gauge rail locomotive cranes without restriction to track facilities. They are suitable for road and excavating contractors, states, municipalities, industrial concerns, coal, sand, gravel and broken stone handling, and surmount obstacles, climb steep grades, run through mud 2 feet deep, turn in a circle of 15 foot radius and unload sand or gravel at a cost of 2 cents per ton. The crawling tread is developed from the government military tank traction, and reduces unit pressure to 10 pounds per square inch. It is adjustable automatically and by set screws.

The cranes are manufactured for operation by steam, electric or gas engine power. They are fitted with 30 or 35-foot booms, or with special booms provided with steam shovel dipper and handle and crowding engine. They will handle a ½-yard to 1½-yard bucket and are made either with crawling tread or road wheels.

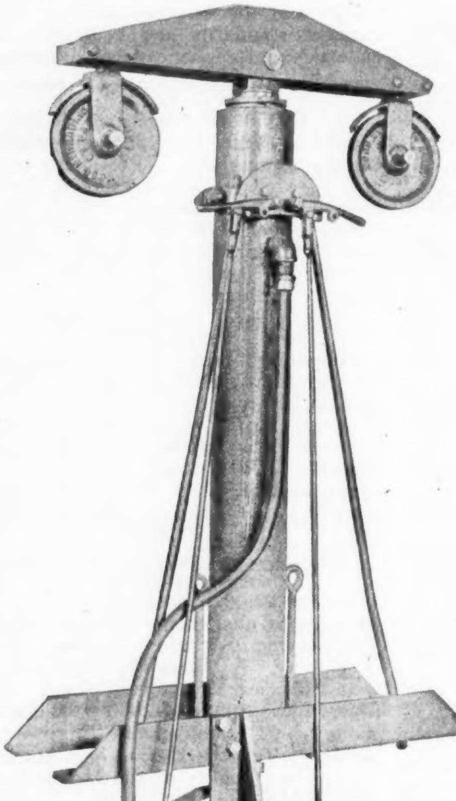
TRUCK HOISTS AND BODIES

The Interboro Hoist & Body Corporation, organized to offer dealers and users complete truck equipment services where a chassis will be equipped completely to meet any requirements, acts as manufacturer and exclusive distributor of platform, stake, high rack, canopy top, express, van and half van truck bodies, Wood hydraulic hoists, all-steel and steel-lined combination wood dumping bodies, hand hoists with dump bodies, cranes and hydraulic hoist services.

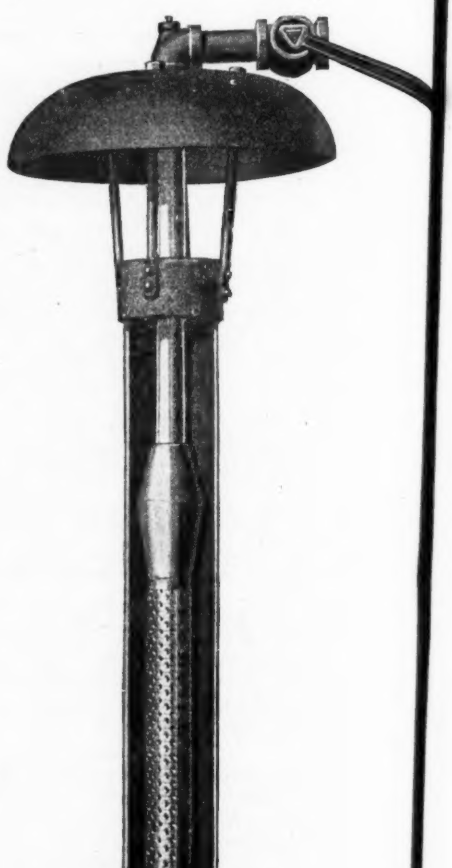
Catalog 2 illustrates many types of platform bodies, including 2-yard and 4-yard dump bodies. Several types and sizes of Wood hydraulic hoists and Meade-Morrison truck winches.

SULLIVAN PUMPS

Air lift pumps, designed and manufactured by the Sullivan Machinery Co., have a central foot piece with an umbrella well top and are provided with strainers to exclude sand from the working barrel of the pump. In order to prevent the clogging of the strainer a method has been developed for displacing the sand close to the strainer with gravel forced down through a pipe driven adjacent to the pump pipe, thus forming a sort of drain which stops the sand and permits the water to flow freely through the strainer. This device is said to often increase the yield of the well 400 per cent.



HYDRAULIC TRUCK BODY HOIST



UMBRELLA WELL TOP

SULLIVAN AIR COMPRESSORS

The Sullivan angle-compound power driver air compressors manufactured by the Sullivan Machinery Co., are illustrated in bulletin 77-B, that deals with three machines of the belted class and two of the direct connected class. These machines, introduced a dozen years ago, are now in extensive use in mines, quarries, shops, water works and on general construction, where it is claimed they deliver more actual compressed air than any other type of air compressor, per unit of power, attention, supplies, installation cost and floor space.

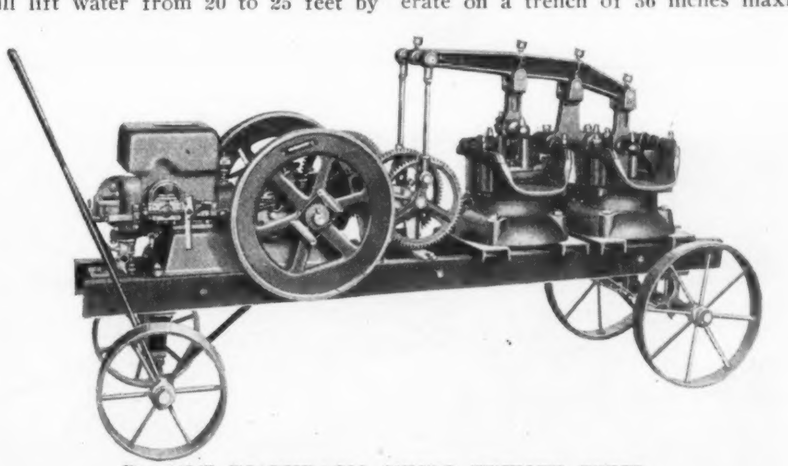
The distinctive features of the angle type compound compressors are that one cylinder with its connecting rod and cross head is almost horizontal, while the other is a high pressure cylinder with its accompanying members is in a vertical plane, and that both are actuated by a single crank. The advantages secured by these features include the balancing of reciprocating forces, small floor space, low cost of installation, low power cost per unit of air compressed, low maintenance cost, flexibility of drive, reduction in care and attention and accessibility. These claims are demonstrated by analysis and illustrated by engravings, made from various pictures of installations and by careful descriptions of the important details of the machine. The construction features include an open hearth steel crank shaft, a band fly wheel made in halves, high and low pressure cylinders with liners placed under hydraulic pressure, air actuated, plate type inlet and discharge valves, a three-pass counter current intercooler with copper or aluminum tubes, stream lubrications for shaft bearings and cross heads and guides, separate oil pumps for the air cylinders. The Class WN-3 compressors are adapted for operation by an electric motor, oil engine or water wheel mounted directly on the crank shaft.

Where more than 1,400 cubic feet of air per minute is required or where the capacity should be variable and elastic within wide limits the Sullivan twin angle compound compressors are recommended. These consist of two single complete compressors set side by side on a common foundation and driven by a common shaft on which is mounted either an electric motor or the belt pulley. These halves of the machine can be installed successively as required or may be detached and operated independently, or one half may be temporarily thrown out of service by closing one of the inlet loaders by hand. If only one quarter of the full capacity is sufficient, one side of the unit is uncoupled and one intake valve removed from the opposite side. For three quarter loads, both sides of the plant would be in commission, but on one side a set of inlet valves would be removed, one from the upper end of the high pressure cylinder and one from the rear end of the intake cylinder. One unit can be cut out leaving the other operating at full load, or one side can be run at full load while the regulation is applied to the other side to meet the demands.

The WI-3 single stage angle compressors compress the air in both cylinders alike from a common inlet conduit or separate inlets as required, the intercooler is omitted, and they are available in single units up to 2,700 cubic feet and for pressures for from 5 to 40 pounds. Air receivers can be provided with capacity of 12 to 376 cubic feet suitable for low pressure cylinder displacements up to 4,000 cubic feet per minute.

JUMBO TRENCH PUMP

The Jumbo diaphragm trench pump for handling large quantities of dirty, gritty water has no complicated parts, no sliding plunger, or cylinder, but two valves and a strong, durable rubber diaphragm with an up and down movement constitutes the pumping mechanism. It is equal to 20 or more men and 12 hand pumps, and is operated at 3 cents per hour per horsepower. It will lift water from 20 to 25 feet by suction, but discharges from the pump by gravity. It has a working speed of 100 r. p. m. and is moundted on a rigid base that may, if required, be placed on standard engine trucks. Either one or two pumps are mounted on the same base and operated by the same engine. It is made in nine sizes, or combination of sizes, with 1¾ and 3 h. p. engines with approximate capacities of 1,800 to 12,000 gallons per minute. The net weight varies from 450 to 1,140 pounds and it is manufactured by the Nelson Bros. Co.



DOUBLE DIAPHRAGM JUMBO TRENCH PUMP

P & H EXCAVATOR CRANE 205

The P & H excavator Crane 205 with accessory buckets, manufactured by the Pawling & Harnischfeger Co., is of all steel construction, mounted on caterpillar tractors, and uses gasoline or distillate fuel and provides a complete independent operating unit with no accessory equipment but the buckets. It has a 30-foot boom with ½-yard drag, scraper, clam-shell or orange peel bucket and has a lifting capacity of from 15,200 pounds at 8-foot radius to 3,300 pounds at 30-foot radius. It weighs 14 tons, has a speed of one mile per hour and is equipped with a 40 h. p., 4-cylinder engine with a drag-line pull of 9,500 pounds at a speed of 100 pounds per minute.

Equipped with a Page bucket it will excavate open or sloping bank ditches, clean out old ditches, dig cellars and regular open trenches, and grade streets. Equipped with a self-acting scraper bucket it will follow the largest size trench excavators and backfill rapidly with one man. Equipped with a clamshell bucket it will load or unload coal, crushed stone, sand, gravel, or any other loose material. It will also serve as a locomotive crane operating any kind of hook, hoisting, or grappling device.

The side wheel excavator makes a cut 18 to 20 inches wide and 14 feet deep, suitable for telephone or gas pipe ditches and is so arranged that it can be operated close to the curb at the same time automatically depositing soil on the opposite side of the trench and reducing the time and cost of the work.

The P & H power traction tamper has a 6-foot wheel base, tread of 56 to 80 inches, and a three horsepower water-cooled four-cycle gasoline engine with friction clutch pulley. It will operate on a trench of 36 inches maximum width at the depth of 7½ feet, using a 150-pound ram with a 9 x 12-inch head and a 20-inch stroke. Its road speed is 1⅓ miles per hour and the feeding speed is 6 feet per minute.

REED ROAD TRACTORS

Tractors manufactured by the Reed Foundry & Machinery Co. are recommended for hauling materials, graders, scarifiers and operating rock crushing machines and for other service in road construction. They are built for performing severe service for many years, and are made in 15-30 and 18-36 sizes, the large size is provided with a 4-cylinder motor and right and left jack shafts driven by independent clutches, obviating the necessity of any differential. The drive wheel has a powerful independent brake, tractors have speeds of 2½ and 3½ miles per hour forward and 1¾ miles reverse. The overall dimensions are 70 x 144 inches by 66 inches high, and weight is approximately 6,000 pounds.

INTERLOCK

Receiving basin, inlet and manhole heads, manufactured and sold by the Interlocking Casting Company, are improved cast iron fixtures of which the covers are at all times interlocked with, and cannot be removed entirely from,

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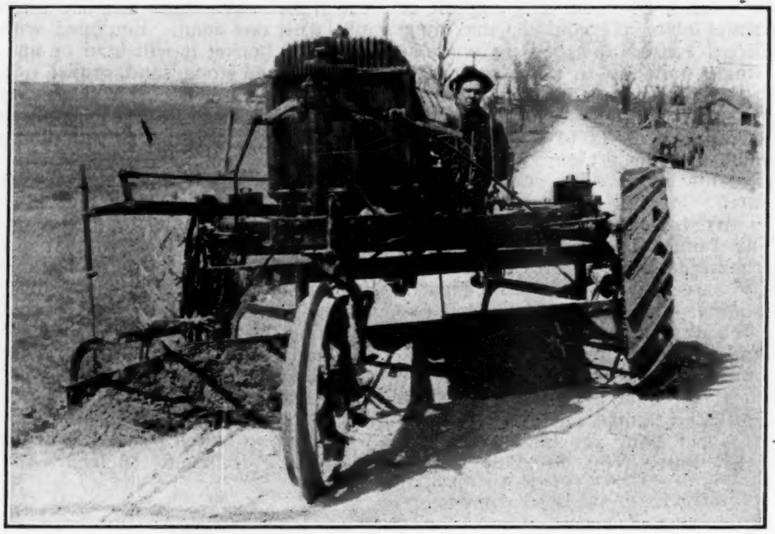
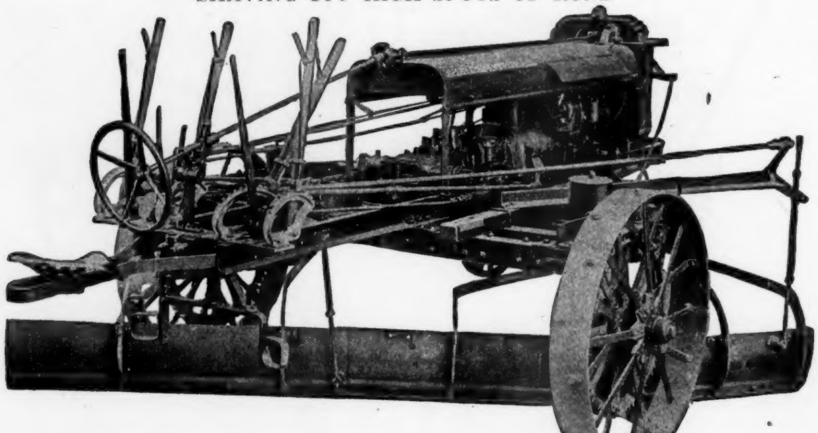
The sixty-six pontoons in the Dardanelle bridge, Arkansas, are fastened together and to several intermediate towers by ½-inch galvanized iron Leschen wire ropes 180 to 225 feet long.



SHAVING OFF HIGH SPOTS OF ROAD



ONE-MAN ROAD-RAZER WITH 3-SECTION FLEXIBLE BLADES

ROAD-RAZER

The One-Man Road-Razer, manufactured by the Avery Company shaves off the high spots and fills up the low spots, can be turned in its own tracks with the one castor wheel and has flexible 3 section blades. It has a 6 cylinder motor and 3 speed reverse.

INDUSTRIAL NOTES

REDUCING LABOR COSTS OF CONCRETE PAVEMENTS

In the construction of an 18-foot pavement 8 inches thick at the center on the Chicago-Joliet road, Ill., the contractor, R. F. Conway Company, unloaded sand and stone with clamshell buckets, the stone was hauled in two trucks to storage on the sub-grade where it was loaded by a Barber-Greene bucket loader into a Lee body on a Ford truck chassis that hauled it 50 feet and delivered to the loading skip of a four-bag batch mixer and returned, shuttlewise, without turning around.

Sand and cement for the 1:2:3½ mix were loaded by hand and a crew of 24 men built an average of 450 linear feet of pavement per 9-hour day.

The loading machine replaced 8 shovelers and was operated by one engineer at $1.25 per hour, one helper at 70 cents per hour and consumed 8 gallons of gasoline at 30 cents and one quart of oil at 80 cents, making, with overtime, a total of $20.77, or $0.023 per square yard of pavement, as compared with the cost of $50.40 for eight shovelers doing the same work for $50.40, thus saving $29.63 per day, or $0.033 per square yard. The total amount of pavement laid was 86,000 square yards.

The London Concrete Machinery Co., Ltd., of London, Ont., is to distribute throughout Canada and the British Empire the pumping equipment manufactured by the Aurora Pump & Manufacturing Co., of Aurora, Ill manufacturers of centrifugal pumps of all types, including turbine pumps for deep wells.

The Nova Scotia Steel & Coal Co., Ltd., and the Dominion Steel Corporation, Ltd., have ratified the agreement merging these two companies with Halifax Shipyards, Ltd., the merger to be conducted under the name of British Empire Steel Corporation, Ltd.

D. Henry Bonner, whose resignation from the Ford Motor Co. was recently announced, has joined the Four-Wheel Drive Auto Co. in the capacity of Sales manager. Mr. Bonner went with the Ford organization in 1914 and made rapid progress, holding many responsible positions. At the time of his resignation he was in charge of assembly operations in all of the branches in the United States.

C. J. Reilly has resigned as general superintendent with the Sandusky Cement Co. to take a position as superintendent of the company's plant at York, Pa. His former position will be discharged, for the present at least, by F. G. Herman. C. B. Roger will be sales manager and will be located at the sales office at Cleveland, Ohio.

F. J. Adams has been appointed superintendent of the Bonner Portland Cement Co. at Bonner Springs, Kan., to succeed U. S. Hannum.

G. C. Knickerbocker, formerly chief chemist of the Knickerbocker Portland Cement Co., at Hudson, N. Y., is now with the Great Western Portland Cement Co., Mildred, Kan., as chief chemist.

TRADE PUBLICATIONS

CONCRETE, ITS MANUFACTURE AND USE

4½ x 7 inches, 207 pages, illustrated, bound in cloth. The Koehring Co., Milwaukee, Wis. This attractive handbook for field use has chapters on materials, field operations, highway construction, forms, reinforcing steel, specifications, bridges and culverts, estimating costs, foundations and footings, waterproofing, submerged concrete, and mechanical equipment; tables for estimating and examples for use of them together with miscellaneous notes for superintendents and foremen.

This book is intended to be a guide to the manufacture and placing of concrete in permanent structures and a suggestion on better care of equipment. It recommends proportions and sizes of aggregate for many different kinds of concrete construction, and shows the minimum storage and number of cars of materials required daily to use with different sized mixers on highway construction. It gives valuable information about ordinary causes for difficulties with machinery, and the best methods for caring for it, and is valuable and convenient for every-day use.

SPEED WITH ECONOMY

Barney-Ahlers Construction Co., 110 W. 40th street, New York, issues a 6-page booklet illustrating a number of industrial buildings, coal pockets and other structures that they have recently built with rapidity.

They base their policy on specializing on industrial construction, medium-sized jobs limited to what they can give personal attention in a given territory. They have prepared standard estimate charts, which they offer to send to inquirers, who will inform them of the approximate size of the building contract, the number of stories, floor load and purpose of building.